MASTER

QUANTITATIVE METHODS FOR DECISION-MAKING IN ECONOMICS AND BUSINESS

MASTER'S FINAL WORK

PROJECT SPECIFICALLY ELABORATED FOR THE OBTENTION OF A MASTER'S DEGREE

UNIFIED CALCULATORS FOR PENSION RECTIFICATION

MARLENE DANTAS LEITÃO

SUPERVISOR:

DR. FILIPE MANUEL GONÇALVES RODRIGUES

OCTOBER – 2023

Acknowledgments

I would like to express my sincere gratitude to several people who have played a significant role in the successful completion of this Master's Final Work.

First, I would like to express my deepest appreciation to my supervisor. His belief in the potential of this project and in me has been a constant source of motivation. His guidance and mentorship have not only enriched this work but have also ignited my curiosity and passion for VBA.

My gratitude extends to my family, whose support has been the cornerstone of my journey. Their encouragement and belief in me have been the driving force behind my achievements and without them, I wouldn't be where I am today.

I would like to thank my work colleagues, especially the Rectification Team and those who started their journey with the company alongside me. Their cooperation and friendship have made the working environment enriching and enjoyable.

To my dear friends, thank you for being a source of strong belief in my abilities and for providing the strength and encouragement needed to overcome challenges. Special thanks to those who have shared this adventure with me since the beginning of this Master's programme.

Finally, my deepest gratitude goes to my boyfriend. His unwavering support and belief in me have been my anchor throughout this academic journey. The constant motivation has given me the confidence and determination to persist and the assurance that every effort will be worthwhile.

Thank you, each and every one of you, for being an integral part of this significant milestone.

Glossary

BC - Benefit Component

BSP - Basic State Pension

CJEU - Court of Justice of the European Union

CPI - Consumer Price Index

DB - Defined Benefit

DC - Defined Contribution

DCPS - Date Commenced Pensionable Service

DOB - Date of Birth

DOD - Date of Death

DOL - Date of Leaving

DOR - Date of Retirement

ERF - Early Retirement Factor

GMP - Guaranteed Minimum Pension

GMPA - Guaranteed Minimum Pension Age

GMPD - Guaranteed Minimum Pension Date

LRF - Late Retirement Factor

MFW - Master's Final Work

NRA - Normal Retirement Age

NRD - Normal Retirement Date

nSP – new State Pension

OPS - Occupational Pension Scheme

RPI - Retail Price Index

SERPS - State Earnings-Related Pension Scheme

SPA - State Pension Age

S2P - State Second Pension

UK - United Kingdom

VBA - Visual Basic for Applications

XS - Excess Pension

Resumo

Este Trabalho Final de Mestrado (TFM) aborda o complexo domínio da retificação de pensões, um processo crítico no cenário de evolução das pensões no Reino Unido. O sistema de pensões do Reino Unido, vital para garantir a estabilidade financeira durante a reforma, passou por transformações significativas ao longo do tempo. Além da pensão estatal, tornaram-se prevalentes os esquemas de pensões privados, cada um com seus componentes distintos. Notavelmente, as disparidades de género nos esquemas de pensão exigiram um processo de Equalização, ordenado pelo Tribunal de Justiça da União Europeia em 1990.

O principal objetivo deste TFM é o desenvolvimento de duas calculadoras com o intuito de otimizar o processo de retificação de pensões, especificamente para as que necessitam de equalização. Estas ferramentas foram projetadas para uma empresa de consultoria global especializada em atuariado e benefícios para funcionários. A primeira calculadora, focada no *Retranching*, redistribui de forma precisa os benefícios de pensão em segmentos de tempo definidos (tranches) com base em regras e diretrizes revistas. A segunda calculadora recalcula o montante da pensão na data da reforma e aplica aumentos anuais nos elementos da pensão desde a reforma até a data atual.

Com estas calculadoras, este projeto tem como objetivo aprimorar a compreensão e a gestão dos direitos de pensão, principalmente no contexto da equalização. O TFM desenrola-se com uma exploração abrangente do sistema de pensões do Reino Unido, seguida de uma exposição detalhada do processo de equalização e dos desafios relacionados ao cálculo dos benefícios de pensão. A metodologia e funcionalidade das calculadoras desenvolvidas são delineadas, destacando o potencial impacto das mesmas na eficiência dos cálculos de pensão e o seu papel em promover a equidade e a precisão na distribuição dos benefícios de pensão.

Palavras-chave: Pensões do Reino Unido; Equalização; *Retranching*; Revalorização; Indexação.

Abstract

This Master's Final Work (MFW) addresses the complex domain of pension rectification, a critical process in the UK's evolving pension landscape. The UK pension system, vital for securing financial stability during retirement, has undergone significant transformations over time. In addition to the state pension, private pension schemes have become prevalent, each with its distinct components. Notably, gender disparities within pension schemes required a process of Equalisation, mandated by the Court of Justice of the European Union in 1990.

The main objective of this MFW is the development of two calculators aiming to streamline the pension rectification process, specifically for pensions necessitating equalisation. These tools have been designed for a global consulting company specializing in actuarial and employee benefits. The first calculator, focusing on Retranching, accurately redistributes pension benefits into defined time segments (tranches) based on revised rules and guidelines. The second calculator recalculates the pension amount at the date of retirement and applies annual increases on pension elements from retirement to the current date.

By providing these calculators, this project aims to enhance the understanding and management of pension entitlements, particularly in the context of equalisation. The MFW unfolds with a comprehensive exploration of the UK pension system, followed by a detailed exposition of the Equalisation process and challenges related to pension benefit calculations. The methodology and functionality of the developed calculators are delineated, underscoring their potential impact on the efficiency of pension calculations and their role in promoting fairness and precision in pension benefit distribution.

Keywords: UK Pensions; Equalisation; Retranching; Revaluation; Indexation.

List of Contents

List of Figures

List of Tables

1. Introduction

A pension is a financial product that provides a stable and regular source of income to support an individual during their retirement years, allowing them to maintain their desired standard of living and meet their financial needs. It represents one of the most tax-efficient methods of saving for retirement because contributions to pension schemes typically qualify for tax relief (Department for Work & Pensions, 2013).

In the United Kingdom (UK), the main objective of the state pension system can be achieved through various ways such as mandatory retirement savings or social insurance programs that provide earnings-related benefits. Over time, the UK pension support system has undergone significant transformations, resulting in a complex framework with a historical dimension. Previous to 2016, the state pension consisted of two parts: the Basic State Pension and the additional State Pension.

In addition to the (public) state pension, individuals may also participate in private pension schemes, like Personal Pension Schemes or Occupational Pension Schemes (OPS). The latter is offered by employers and involves two components: Excess Pension (XS) and Guarantee Minimum Pension (GMP). The GMP is the portion 'contracted-out'[1] from the additional State Pension that employers are required to provide to employees, ensuring that they would not be disadvantaged if they opted for a private scheme.

Surprisingly, gender disparities within the GMP component of pension schemes introduced distinct rules for men and women, resulting in unequal treatment. This fact highlighted the need for equalisation efforts to address these inequalities and promote fairness in pension provisions. In 1990, the Court of Justice of the European Union (CJEU) mandated equal treatment between men and women in OPS, leading to the concept of GMP Equalisation. In response, pension schemes in the UK are now obligated to equalise their pension benefits. Nevertheless, the methods for achieving this equalisation can vary among different schemes, resulting in a complex landscape of rules and regulations.

With so many changes, the need to rectify pensions arose. Rectification is a calculation method involving the amendment of pension values based on specific events such as wrong

---

[1] 'Contracting-out' occurs when individuals give up the additional State Pension, paying a reduced rate of National Insurance, and instead contribute to a private pension scheme.

assumptions, errors committed in the past, or new rules that are still to be applied to members of a specific scheme.

The purpose of this Master's Final Work (MFW) is the development of two calculators in Microsoft Excel, using the Visual Basic for Applications (VBA) programming language, that intend to streamline the process of rectifying pension benefits for a global company that provides actuarial and employee benefits consulting. This goal can be achieved by automating and standardising the process, adding the ability to define the main rules of the scheme *a priori*. This results in a decrease in working time per case and facilitate the verification work by making the checker familiar with the layout and procedures. Furthermore, this MFW aims to clarify the process of pension rectification.

The first calculator redistributes the pension benefits accurately into time segments (tranches) according to revised rules and guidelines to obtain the retranched pension of the member at his date of leaving the scheme (DOL). This process is called Retranching and may involve adjusting the size, distribution, or other characteristics of the tranches to ensure compliance with the new rules and to provide beneficiaries with the appropriate pension rights they accumulated when contributing to the scheme.

The second calculator recalculates the pension amount at the date of retirement (DOR) and applies the correct increases on the pension elements from the DOR to the current date, ensuring accurate and fair adjustments to pension amounts.

By providing these calculators, this MFW aims to facilitate the understanding and management of pension entitlements, particularly in the context of equalisation and the diverse rules governing pension schemes. This work contributes to the broader goal of promoting efficiency in pension calculations, ultimately helping individuals in planning for their retirement and ensuring the fair distribution of pension benefits.

This MFW is structured as follows: Section 2 starts with some key definitions and a clear overview of the long-term history of the UK pension system and its components. Attention then turns to the GMP Equalisation process and its consequences, and it outlines the issues related to calculating pension benefits. Section 3 describes the methodology of the Retranching and Equalisation processes. Section 4 presents the developed calculators and explains step-by-step how to work with them. The last section analyses the impact of the two calculators on the company and assesses aspects of their performance.

2. UK Pension System

The UK pension system is complex and has a historical dimension, as shown in Figure 1. In 1948, the Basic State Pension (BSP) was created to provide a flat-rate[2] pension to individuals who have made sufficient National Insurance contributions during their working lives (Bozio, et al., 2010). This pension was payable from the state pension age (SPA) to the date of death (DOD). The SPA is the age at which individuals become eligible for the state pension, 65 for men and 60 for women, and it has been increasing (Crawford, et al., 2013). In 1978, the State Earnings-Related Pension Scheme (SERPS) was introduced as an additional pension scheme based on an individual's earnings and National Insurance contributions, with higher earners receiving a larger benefit (Banks & Emmerson, 2018).

The SERPS was originally introduced to provide a supplementary pension to the BSP; however, in April 2002, it was replaced by the State Second Pension (S2P) aiming to benefit low to moderate earners who had not built up significant pension entitlements through workplace pensions (Daykin CB, et al., 2002). In April 2016, it was introduced a new pension – called the new State Pension (nSP) – based on an individual's National Insurance contributions. This new pension comes to replace both the S2P and the BSP (Banks & Emmerson, 2018). For this MFW, the focus will be given essentially to the period covering SERPS.
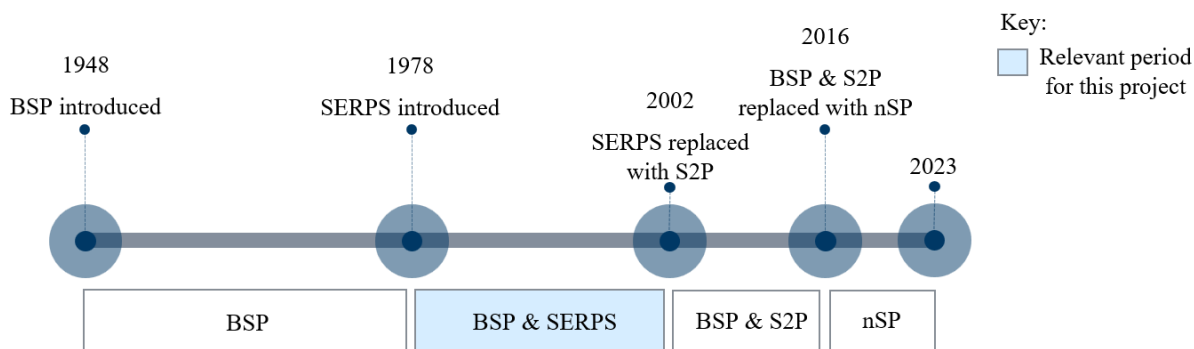
Figure 1.Chronological evolution of the UK state pension system.

The pension benefits available to an individual depend not only on their National Insurance contributions but also on the date they made them. With contributions made decades before benefits are received, and rules that determine how much an individual is entitled to changing over time, individuals retiring today can still be affected by rules and systems that

---

[2] A flat-rate pension is a type of retirement benefit where the amount paid is fixed and is not dependent on past earnings or contributions.

existed over 40 years ago (Harrison & Blake, 2013). According to Bozio et al. (2010), "*it is not just the current system that matters, but also any previous systems under which an individual accrued an entitlement*". Therefore, understanding the long-term history of the UK pension provisions is essential for a clear overview of the system.

2.1. Occupational Pension Schemes

In addition to the state pension, individuals may also build up further pension entitlement by participating in other pension funds (schemes). There are three pillars of support in old age: the state system, as explained before; the Occupational Pension Scheme (OPS), a pension provided by the employers for their employees; and the personal pension scheme, an individual retirement savings plan (Mayhew, 2001). State pensions in the UK are among the lowest in Europe because of the long-standing funded private pension sector (Blake, 2000). This was particularly influenced by the fact that individuals were given the option to 'contract-out' of SERPS and instead invest in an OPS (Thurley, 2021).

OPSs are differentiated according to whether they are 'salary-related', called defined benefit (DB) plans, or 'money purchase', called defined contribution (DC) plans (Disney, 1995). In DB plans, which will be the focus, a certain level of pension benefits is promised based on the individual's years of service and earnings (Banks & Smith, 2006). These plans 'tilt' benefits towards individuals with longer job tenures, resulting in a redistribution of benefits from early leavers to long-term employees (Disney, 1995). In DC plans, the pension scheme commits the member to a level of contributions, but there is no explicit commitment to a level of pension benefits. The pension annuity paid depends on contributions, investment returns, and transaction costs.

The OPSs based on DB plans are designed to ensure effective management and potentially generate higher returns in the future. The pension benefits from these schemes consist of two elements: the Guaranteed Minimum Pension (GMP) and the Excess Pension (XS).

Guaranteed Minimum Pension (GMP)

According to the Department of Health and Social Security (1978), employees that 'contracted-out' into an OPS based on DB plans would pay lower contributions to the state, and instead of receiving the SERPS, the pension scheme providers (employers) were required to offer a minimum level of pension, the GMP. The accumulation of GMPs was stopped from

6th April 1997 onwards (UK Parliament, 1995). However, pension schemes are still responsible for ensuring the provision of GMPs in accordance with the rights earned from 1978 until that date (Thurley, 2021).

The major concern of the government regarding individuals who were part of OPS based on DB plans was that these individuals must not incur any detrimental effects as a consequence of being associated with a 'contracted-out' scheme (National Audit Office, 2016). Moreover, when a member reaches the GMP entitlement age (GMPA)[3], the GMP is paid by the employer and the difference between the GMP amount and the SERPS built up between 1978 and 1997 is paid by the state to the member (Thurley, 2014).

The GMP is subject to a unique and complex calculation for each individual. Due to the complexity of this calculation, members who wish to obtain precise information about their entitlement should contact either the specific pension scheme or His Majesty's Revenue & Customs directly.

Excess Pension (XS)

The extra portion over the GMP, *i.e.*, the difference between the total pension and the GMP is referred to as 'non-GMP pension' or 'excess pension' (James, 2002). In contrast to the GMP, the XS benefits are not subject to the GMP requirements. The rules and provisions for XS benefits are scheme-specific and can include different retirement ages and rates (Davis, 1993).

The calculation and payment of these benefits are determined by the rules set out in the pension scheme's documentation. Generally, XS benefits are determined based on factors such as the salary, length of service, and contributions made to the pension scheme.

It is important for individuals to understand the specific terms and conditions of their XS benefits. This knowledge can help them make informed decisions about their retirement plan and ensure that they receive the appropriate pension entitlements based on their scheme.

Revaluation and Indexation

OPSs based on DB plans have statutory minimum requirements that dictate how pensions in deferment and pensions in payment must increase. The deferment period corresponds to the duration between leaving active membership (where members are no longer

---

[3] GMPA is 60 for women and 65 for men, and these values remain fixed despite the SPA increasing.

contributing to the scheme) and reaching the scheme pension age. Revaluation specifically refers to annual increases in deferred pensions[4]. Deferred XS rights must be revalued in line with prices, but the revaluation rate is bounded. For pension benefits accrued before 5 April 2009, the limit is 5%, which reduces to 2.5% for benefits accrued thereafter.

Indexation involves annual increases to protect the value of a member's pension from inflation while receiving payments, that is from the date of retirement onwards. The indexation of the XS in payment is based on inflation and is limited at 5% for benefits accrued from service between April 1997 and April 2005 and at 2.5% for benefits accrued from April 2005 thereafter (Department for Work & Pensions, 2010). OPSs are not required to index pension rights accrued before 1997.

Although the legislation does not specify a particular measure of prices to be used for pension increases, only that they should be in line with the general level of prices in Great Britain (Department for Work & Pensions, 2011), the Retail Prices Index (RPI) has been used historically, see Appendix 1. However, in July 2010, the Government announced that it would use the Consumer Prices Indexation (CPI) from April 2011 onwards (Thurley, 2014).

These annual increases, for pensions in deferment or in payment, are outlined in an annual 'revaluation order' and represent the minimum that schemes are required to provide. However, the specific regulations regarding revaluation and indexation of pensions differ across various pension schemes and may exceed the minimum standards required by law, *i.e.*, schemes can choose to offer more generous arrangements (Thurley, 2012).

Furthermore, other variables may impact an individual's pension entitlement, which is dependent on the scheme's rules. In contrast to the clear rules governing the public pension system, the private sector exhibits significant diversity. Individuals can be enrolled in a wide range of pension schemes with varying rules and provisions. Without knowledge of a person's specific pension plan, it is impossible to estimate their entitlements accurately (Attanasio & Rohwedder, 2003).

OPSs based on DB plans usually encourage individuals to receive their pension, that is to retire, at the normal retirement age (NRA) since they generally apply an actuarial reduction if the pension is received before this age (Banks, et al., 2016) and a late retirement uplift for postponing the pension (Department for Work & Pensions, 2019). The NRA for a pension

---

[4] Deferred pension refers to the total pension accumulated until the member leaves the scheme but is not paid until the individual retires.

scheme member is determined by the rules of the scheme in which they enrolled. However, the GMP portion can only enter into payment after the GMPA.

Under existing rules, there is no statutory requirement for pension schemes to increase GMPs accrued between 6 April 1978 and 5 April 1988, but pension scheme providers are required to pay increases on GMPs accrued between 1988 and 1997 by the lower of inflation or 3%, on 6 April each year (HC Deb, 2014). The UK Government's Department for Work and Pensions recalculates the state pension payable each year, to ensure that a person's GMP entitlement is uprated, and publishes the 'Guaranteed Minimum Pension Increase Order' that contains the annual increases for GMPs (Thurley, 2014).

2.2. GMP Equalisation

From the time 'contracting-out' emerged, GMPs were calculated on an unequal basis because the age at which it can be drawn and rate at which benefits build up are different for men and women. This reflected inequalities in the amount of pension income received.

Women were entitled to receive their GMP at an earlier age (60) than men (65), which created differences in the GMPs payable to each gender. In acknowledgement of the fact that women's working lives for state pension purposes were five years shorter than those of men, a woman's GMP accrual rate was higher than a man's (Department for Work & Pensions, 2019). Consequently, if a man and a woman have an equivalent employment history, the woman's GMP will be greater than that of the man.

The discrepancy between the amount of GMP payable to men and women is also due to the indexation and revaluation conditions. As the GMPA is not the same for both genders, women are entitled to GMP indexation in payment during periods when a man of the same age is entitled to revaluation on a GMP that has not yet been paid out (Department for Work & Pensions, 2019).

While the rates of revaluation and indexation do not differ between genders, revaluation rates are different from indexation rates. This means that a woman's GMP may initially be higher than that of a comparable man, but over time, the value of the man's GMP may exceed that of the woman's (Thurley, 2021).

For instance, consider the scenario illustrated in Figure 2 of a man and a woman who have the same date of birth (DOB). Both individuals join the pension scheme at 30, and

therefore have an equal date commence pensionable service (DCPS), leaving the scheme at the age of 50 (date of leaving - DOL). In this way, they will preserve a deferred pension from age 50 until the date of retirement (DOR). However, there is a distinction based on gender. The woman is eligible to receive a pension at the age of 60 (NRA), resulting in her pension being deferred from age 50 to 60, with the corresponding revaluation applied during this period. Subsequently, after reaching the age of 60, her pension will commence with the annual increases. In contrast, the male individual, upon leaving the scheme at 50, will experience a longer deferment period if he chooses to wait until the NRA of 65. If so, it is only at the age of 65 that his pension becomes payable, and thus will have a longer revaluation period than a female member.
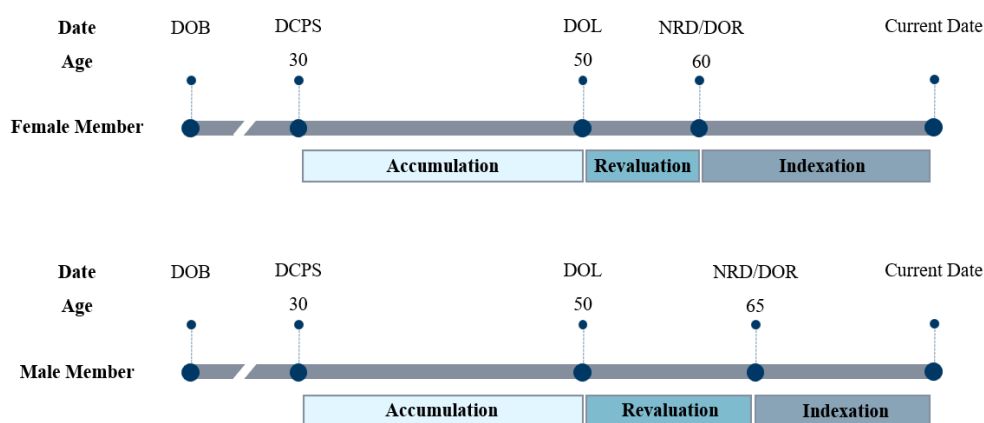
Figure 2. Impact of different NRAs between genders on revaluation and indexation.

The Barber Judgement

A misconception surrounding the term 'pay' was resolved in 1990 when the *Barber v. Guardian Royal Exchange Assurance Group* case led to a significant decision by the Court of Justice of the European Union (CJEU). The CJEU ruled that the OPs should be considered as a payment, making them subject to equal treatment for both men and women (Fitzpatrick, 1991).

According to Moffat & Luckhaus (1998), the Barber judgement case proved to be "*the turning point in the application of the principle of equal treatment to occupational pension schemes*". The requirement to equalise pension ages and scheme benefits was established, but only for the rights that were earned from the period of employment after 17 May 1990. In the long-running case, employers were told to set a date of equalisation after which they must level up women's pension age to that of men's to achieve equality. However, for the period between 17 May 1990 and that date of scheme equalisation, the benefits accruing for the advantaged

group during this time frame, commonly known as the 'Barber window', must be extended to those of the disadvantaged group, in other words, both genders must be provided with the more favourable benefits (New Law Journal, 2020).

Equalisation Methods

The responsibility for implementing the equalisation of pension schemes lies with the OPS trustees[5]. Each scheme manager has the discretion to determine the specific method they will employ to achieve equality.

After the Lloyds Bank case on 26 October 2018, the High Court confirmed that there is no prescribed method for trustees to follow in equalising pensions. The judge ruled that trustees should equalise the overall pension rather than each individual component of the pension, as they do not have the authority to modify GMP legislation. Additionally, the trustees should choose the method that carries out the minimum of interference with the rights of the affected members and the employer (Department for Work & Pensions, 2019).

Among the various approaches that have been considered, the method that aims to minimize disturbance with the members' rights and minimize costs for the company is to compare the pension actually paid to a male and a female member (with comparable pensionable service history) on a year-by-year basis and provide the higher amount (James, 2002).

As part of the Equalisation process, discrepancies in pension amounts may arise between the actual payments made and the payments that should have been made according to the new rules. These discrepancies need to be rectified by ensuring that the appropriate amount is paid to the members of the pension scheme. According to HM Revenue & Customs (2022), in cases where a pension has been underpaid, the scheme administrator is required to correct the annual amount and pay arrears of pension. In addition to the arrears, interest may also be payable for the late payment of pension instalments. This interest is an additional amount that is earned on top of the arrear amount each year and is typically calculated at a rate of 1% above the base rate on a simple basis, *i.e.*, 1% more than the base rate set by the Bank of England. For example, if the base rate is 2%, the interest within the pension scheme would be 3% (base rate + 1%).

---

[5] An OPS trustee is an individual or a group of individuals appointed to oversee and manage the assets and operations of an OPS, ensuring that it is administered in compliance with the law and the rules and regulations of the scheme.

3. Methodology

This section provides an extensive examination of the adopted methodologies for the two developed calculators: one to facilitate the Retranching process for deferred pensions and another for the Equalisation process, which involves the Revaluation and Indexation of pension benefits for retired members.

All the necessary data provided by a pension fund management company is securely stored in a confidential software system. The initial task involves extracting the data into Microsoft Excel while ensuring the protection of members' personal information by anonymizing and excluding any identifiable details. It is also important to note that the examples and methodologies discussed herein represent standard practices, applicable to the majority of projects, and specific cases would be incorporated into the calculators manually. For this matter, the equalisation date considered will always be prior to 05/04/1997.

3.1. Retranching Process

Retranching is a process applied to members who are no longer contributing to the scheme but have not retired yet. It consists of accurately dividing the deferred pension benefits into several categories (called benefit components) over new time-segments (called tranches) in alignment with the revised scheme provisions. It may involve adjusting the size, distribution, or other characteristics of the tranches to ensure compliance with the new rules and to provide fair and appropriate pension entitlements to the beneficiaries.

To provide a tangible illustration and enhance the comprehension of the process, Table 1 shows an example of a deferred pension distribution based on a three-tranche approach corresponding to the period of contributions. This pension is also divided into three benefit components (A, B, and C). After the Retranching process, the revised pension benefits are divided into the same three tranches with the corresponding components but new date ranges and benefit components amounts, as shown on the right side of Table 1. The detailed Retranching process – tranches to consider, benefit components in each tranche, and how to calculate the amount corresponding to each benefit component in each tranche - is explained next.

Table 1. Example of the Retranching process with the old pension at DOL on the left side and the revised pension at DOL on the right side.

Old Pension at DOL					Revised Pension at DOL			
Tranche	Benefit Component	Start Date - End Date	Amount		Tranche	Benefit Component	Start Date - End Date	Amount
1	A	01/04/1976 - 16/05/1990	£ 59.28		1	A	16/09/1985 - 16/05/1990	£ 59.28
	B		£ 70.68			B		£ 70.68
	C		£ 538.59			C		£ 538.59
2	B	17/05/1990 - 18/08/1994	£ 121.46		2	B	17/05/1990 - 31/12/1991	£ 54.45
	C		£ 418.80			C		£ 187.75
3	B	19/08/1994 - 05/04/1997	£ 109.18		3	B	01/01/1992 - 05/04/1997	£ 176.19
	C		£ 376.44			C		£ 607.49

Let us start by focusing on the definition of the tranches to consider. According to standard practice, the division of the total pension at DOL, also referred to as the Scale Pension, follows a theoretical logic based on the evolution of the UK pension system (Table 2). To address the equalisation changes between 1990 and 1997, discussed in Section 2, a three-tranche approach is adopted to ensure appropriate future treatment of each benefit component. The first tranche encompasses benefits accrued before the Barber judgement, that is, from the date the member started contributing to the scheme (DCPS) to May 17th, 1990. The second tranche, known as the Barber Window, spans from the day after the judgement (17/05/1990) to the equalisation date determined by the scheme trustees. The third tranche covers the period from one day after the equalisation date to April 5th, 1997, which marks the end of GMP accumulation.

For tranches after April 6th, 1997, each scheme may choose to further divide the service into varied tranches. The most common approach includes tranche 4, which refers to the period until 2005, marking the change in the indexation rate; tranche 5, covering the period from post-2005 until 2009, reflecting the change in the revaluation rate from that date; and tranche 7, encompassing the period from post-2009. It should be noted that tranche 6 is not commonly used and will not be covered in this project.

Table 2. Tranche description and standard start and end date of each.

Tranche	Description [6]	Start date	End date
1	Pre 17/05/1990	DCPS	16/05/1990
2	Post 16/05/1990 and pre equalisation	17/05/1990	Equalisation date
3	Post equalisation and pre 06/04/1997	Next day after equalisation date	05/04/1997
4	Post 05/04/1997 and pre PA04	06/04/1997	05/04/2005
5	Post PA04	06/04/2005	05/04/2009
7	Post 2009 Revaluation Reduction	06/04/2009	DOL
99	Unknown	-	-

Tranche 99 includes other benefit components that are either informative or non-linear benefit components that do not make sense to be added to any existing tranche. The most common approach is to keep the Scale Pension in that tranche, but it can also include Transfers-In, *i.e.*, pension amounts transferred from other schemes to the current scheme, or other non-linear components.

It is worth mentioning that some schemes may have different splits, resulting in modification of tranches start and end dates to facilitate the treatment of components within each tranche. The majority of tranches commence on April 6th and conclude on April 5th of another year, as this time frame aligns with the full tax year.

Each member of the scheme will only have the tranches in which they had pensionable service. For example, if a member enters the scheme on 20/07/1992 and leaves on 01/08/2004, considering an equalisation date defined by the scheme as 05/04/1994, the member will only have tranches 2, 3, 4, and 99 (Table 3).

---

[6] The descriptions of the tranches provided in this section are predefined and specific to the software. Regardless of any alterations in dates, the designations of the tranches will remain consistent.

Table 3. Example of the Pension at DOL division into tranches for a member with service between 20/07/1992 and 01/08/2004 and equalisation date as 05/04/1994.

Tranche	Description	Start date	End date	Value
2	Post 16/05/1990 and pre equalisation	20/07/1992	05/04/1994	£ 554,48
3	Post equalisation and pre 06/04/1997	06/04/1994	05/04/1997	£ 972,34
4	Post 05/04/1997 and pre PA04	06/04/1997	01/08/2004	£ 2.373,18
99	Scale Pension	20/07/1992	01/08/2004	£ 3.900,00

As mentioned before, each tranche comprises a combination of different benefit components (BCs). A list of all BCs can be found in the Appendix 2. It includes BCs associated with the GMP portion and with the XS portion. The BCs associated with the GMP portion, namely Pre 88 GMP and Post 88 GMP, divide the GMP into prior 5 April 1988 portion and post portion. The BCs associated with the XS portion can be categorized into Revaluing Excess Pension and Non-Revaluing Excess Pension, each one having different subcategories.

The value of the Pension at DOL (P_{DOL}) for a deferred member can be calculated either as the aggregation of all the member's benefit components (1) or by considering the progressive accumulation of the pension during the time the member contributed (2). That is,

$$P_{DOL} = \sum_{x=1}^{X} BC_x \tag{1}$$

$$P_{DOL} = S * FPS * R \tag{2}$$

where X is the number of different BCs in the scheme, BC_x is the value of the benefit component x, with $x=1,...,X$, S is the length of pensionable service between DCPS and DOL, FPS – or Final Pensionable Salary - is the amount on which the final benefits are calculate as defined in the rules of the scheme, and R is the accrual rate, *i.e.*, the percentage rate charged on FPS.

Formula (2) indicates that the pension value (P_{DOL}) is proportional to the length of the pensionable service (S). Thus, in the Retranching process, the pension value associated with each benefit component in each new tranche is proportional to the associated pensionable service. This means that the value of the benefit component x in each new tranche t can be obtained by multiplying the sum of the value of such benefit component in all the original

tranches by the total pensionable service it corresponds to, and then dividing it by the service of all tranches where this benefit will be allocated.

More formally, let us denote by T the set of old tranches and by T' the new set of tranches to redistribute the pension benefits. The value of the benefit component $x \in \{1, \dots, X\}$ in the new tranche $t \in T'$ – denoted by $BC_{x,t}^{new}$ – can be computed as

$$BC_{x,t}^{new} = \frac{\sum_{i \in T} BC_{x,i}^{old} * S_{x,t}^{new}}{\sum_{i \in T'} S_{x,i}^{new}} \qquad (3)$$

where:

$BC_{x,i}^{old}$ - old value of the benefit component x in tranche $i \in T$;

$S_{x,i}^{new}$ – pensionable service of BC_x in the new tranche $i \in T'$.

The pensionable service could be calculated in complete years, months, or days. The GMP service is always calculated in days, but the XS portion will depend on scheme rules.

Typically, three reasons lead to the need for the Retranching process:

i)   when pre-97 benefits are consolidated into a single tranche, referred to as tranche 0;

ii)   when there is a change in the equalisation date leading to a change in tranches 2 and 3 date ranges;

iii)   when there is a change in the date ranges of the post-97 tranches.

Next, these three situations are explained in detail, and the application of the Retranching process to them is exemplified.

Case 1: Benefits consolidated in a single tranche

Proceeding with the first case, if the member has BCs accrued prior to 1997 in tranche 0, what follows is dividing them in a precise and appropriate manner into three tranches (Table 4). The new value of each BC in each pre-97 tranche can then be computed by using Formula (3) considering $T = \{0\}$ and $T' = \{1,2,3\}$.

This analysis allows to identify the value of each BC in each new tranche, resulting in the division of the pre-97 pension into three distinct segments based on the start and end dates of the tranches. Table 4 shows a simplified demonstration of this type of Retranching.

Table 4. Example of a Retranching process of a single tranche to a 3-tranche approach, with an equalisation date as 31/12/1991.

Old Pension at DOL					Revised Pension at DOL			
Tranche	Benefit Component	Start Date - End Date	Amount		Tranche	Benefit Component	Start Date - End Date	Amount
0	Pre 88 GMP	16/09/1985 - 05/04/1997	£ 59.28		1	Pre 88 GMP	16/09/1985 - 16/05/1990	£ 59.28
	Post 88 GMP		£ 301.32			Post 88 GMP		£ 70.68
	Revaluing Excess Pension (REP) 1		£ 1,333.83			REP 1		£ 538.59
					2	Post 88 GMP	17/05/1990 – 31/12/1991	£ 54.45
						REP 1		£ 187.75
					3	Post 88 GMP	01/01/1992 - 05/04/1997	£ 176.19
						REP 1		£ 607.49

To calculate the pensionable service, it is essential to highlight that the Pre 88 GMP and Post 88 GMP require distinct treatment compared to other BCs due to their limited existence, from 6 April 1978 to 5 April 1988 the former and from 6 April 1988 to 5 April 1997 the latter. As a result, only the days within these ranges should be counted in the corresponding tranche(s). For this example, $S^{new}_{Pre\ 88\ GMP,1} = 933$ days (from 16 September 1985 to 5 April 1988), but because it was originally in one tranche and now it will be only in one tranche too, there is no need to split. For the Post 88 GMP, the tranches 1 and 3 also demand some caution with dates, $S^{new}_{Post\ 88\ GMP,1} = 771$ days (from 6 April 1988 to 16 May 1990), $S^{new}_{Post\ 88\ GMP,2} = 594$ (from 17 May 1990 to 31 December 1991); $S^{new}_{Post\ 88\ GMP,3} = 1922$ (from 1 January 1992 to 5 April 1997). For the XS benefits, the service takes into account only the date ranges of the tranches: $S^{new}_{REP1,1} = 1704$ (from 16 September 1985 to 16 May 1990), $S^{new}_{REP1,2} = 594$ (from 17 May 1990 to 31 December 1991), $S^{new}_{REP1,3} = 1922$ (from 1 January 1992 to 5 April 1997).

After determining all the pensionable service values, it is possible to calculate the value of each new BC, like the examples below.

$$BC^{new}_{Post\ 88\ GMP,1} = \frac{BC^{old}_{Post\ 88\ GMP,0} * S^{new}_{Post\ 88\ GMP,1}}{\sum_{i=1}^{3} S^{new}_{Post\ 88\ GMP,i}} = \frac{301.32 * 771}{3287} = 70.68$$

$$BC_{REP1,1}^{new} = \frac{BC_{REP1,0}^{old} * S_{REP1,1}^{new}}{\sum_{i=1}^{3} S_{REP1,i}^{new}} = \frac{1,333.83 * 1704}{4220} = 538.59$$

Case 2: Change in the equalisation date

As previously stated, in certain cases, instead of having a tranche 0, it may be necessary to restructure the three tranches already in place, for example, when there are changes in the equalisation date. While the BCs in tranche 1 remain unchanged, tranches 2 and 3 are subject to modification. In this case, the calculation method will be the same as Formula (3) considering $T = \{2,3\}$ for the numerator and $T' = \{2,3\}$ in the denominator. An example of this type of Retranching is shown in Table 5.

Table 5. Example of the Retranching process for a change in equalisation date from 31/12/1993 to 31/12/1991.

Old Pension at DOL				Revised Pension at DOL			
Tranche	Benefit Component	Start Date - End Date	Amount	Tranche	Benefit Component	Start Date - End Date	Amount
1	Pre 88 GMP	16/09/1985	£ 59.28	1	Pre 88 GMP	16/09/1985	£ 59.28
	Post 88 GMP	-	£ 70.68		Post 88 GMP	-	£ 70.68
	REP 1	16/05/1990	£ 538.59		REP 1	16/05/1990	£ 538.59
2	Post 88 GMP	17/05/1990 -	£ 121.46	2	Post 88 GMP	17/05/1990 -	£ 54.45
	REP 1	31/12/1993	£ 418.80		REP 1	31/12/1991	£ 187.75
3	Post 88 GMP	01/01/1994 -	£ 109.18	3	Post 88 GMP	01/01/1992 -	£ 176.19
	REP 1	05/04/1997	£ 376.44		REP 1	05/04/1997	£ 607.49

Case 3: Change in the date ranges of the post-97 tranches

Regarding the post-97 period, the distribution of the pension can either remain unchanged or become subject to the new scheme rules. The latter case refers to the final type of Retranching previously mentioned. For this purpose, Formula (3) is used for the post-97 tranches, meaning $T = T' = \{4,5,7\}$. Table 6 shows an example of the Retranching process considering a change in the date ranges of tranches 4 and 5.

Table 6. Example of the Retranching process for a change in the date ranges of tranches 4 and 5.

Old Pension at DOL				Revised Pension at DOL			
Tranche	Benefit Component	Start Date - End Date	Amount	Tranche	Benefit Component	Start Date - End Date	Amount
4	Revaluing Excess Pension 1	06/04/1997 - 05/04/2006	£ 2,956.80	4	Revaluing Excess Pension 1	06/04/1997 - 05/04/2005	£ 2,628.27
5	Revaluing Excess Pension 1	06/04/2006 - 05/04/2009	£ 985.60	5	Revaluing Excess Pension 1	06/04/2005 - 05/04/2009	£ 1,314.13
7	Revaluing Excess Pension 1	06/04/2009 - 30/09/2010	£ 492.80	7	Revaluing Excess Pension 1	06/04/2009 - 30/09/2010	£ 492.80

The three types of Retranching mentioned before can be used either independently or together if the scheme requires it. After performing the Retranching process, the next step is to present the results to the checker and, after approval, build a summary paper with the old and new revised values to present to the client. If the client agrees with the changes, it is necessary to organise all the information into a standard template to implement back into the system. This template allows to see line by line each BC of the member and its information: corresponding tranche, start and end date, benefit type, benefit amount, first payment due, and so on.

3.2. Equalisation Process

In the preceding subsection, it was explored the Retranching process. Building upon the theory discussed in Section 2, this section delves into the practical application of equalisation, which plays a crucial role in the pension value of the members who contributed to the scheme during the period of equalisation.

Once the scheme has reached an agreement to carry out an Equalisation process, the subsequent step involves its implementation. To that end, the scheme designates new rules of pension revaluation between women and men, ensuring that both genders benefit equitably from this initiative and receive fair pensions. This is achieved through a recalculation involving revised normal retirement age (NRA) values.

For members who are already receiving pension payments, a realignment of their pensions becomes imperative. This adjustment ensures that these members receive their pensions with accuracy and precision.

The Equalisation process encompasses two main stages: Revaluation and Indexation (Figure 3).
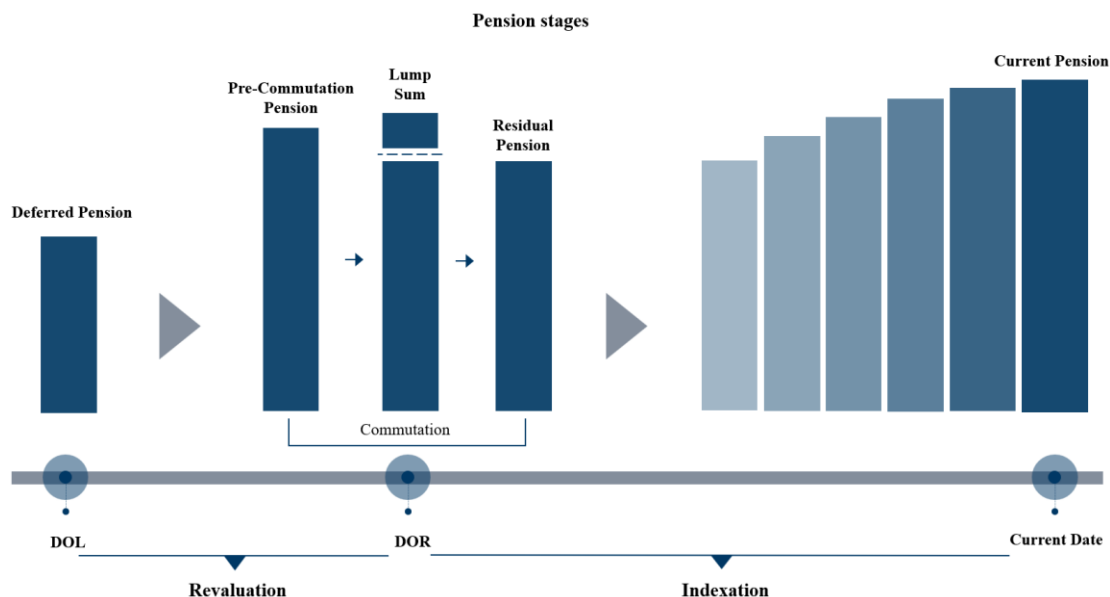
Figure 3. Pension main stages: Revaluation and Indexation.

The first stage commences with the total pension accrued by the member during the contribution period up to the date of leaving the scheme (DOL). This total pension is called deferred pension. Although the member has left the scheme, the benefits remain and are revalued until the member retires (DOR). At the point of retirement, the member has the option to take a tax-free lump sum, resulting in a reduction of the pension. The amount of pension before the lump sum is called 'Pre-Commutation Pension', while the amount after is called the 'Residual Pension'. After the DOR, the Residual Pension undergoes annual increases, constituting the second main stage of this process, Indexation.

3.2.1. Revaluation

In the Revaluation process, the deferred pension will be revalued during the period of deferment, from DOL to DOR or NRD, at a specific rate. If a member retires before or after his normal retirement date (NRD), he will be penalized/benefited, and a retirement factor will

be applied. The revised value of the Pension at DOR (P_{DOR}^{new}) can be calculated as the sum of the XS at DOL[7] (P_{DOR}^{XS}) and the GMP at DOL (P_{DOR}^{GMP}), which follow the formulas below:

$$P_{DOR}^{new} = P_{DOR}^{XS} + P_{DOR}^{GMP} \tag{4}$$

$$P_{DOR}^{XS} = \sum_{i \in T} \left[P_{DOL,i}^{XS} * \left(1 + r_i^{XS}(x)\right) * RF_i^{XS}(y) \right] \tag{5}$$

$$P_{DOR}^{GMP} = \sum_{i \in T} \left[P_{DOL,i}^{GMP} * \left(1 + r_i^{GMP}(x)\right) * RF_i^{GMP}(y) \right] \tag{6}$$

where, for each tranche $i \in T = \{1,2,3,4,5,7\}$,

$P_{DOL,i}^{XS}$ /$P_{DOL,i}^{GMP}$ – the value of the XS/GMP portion of the deferred pension at DOL in tranche i;

$r_i^{XS}(x)$/ $r_i^{GMP}(x)$ – the revaluation rate of the XS/GMP portion of tranche i according to the period of deferment x;

$RF_i^{XS}(y)$/ $RF_i^{GMP}(y)$ – the retirement factor of the XS/GMP portion of tranche i according to the number of years y between DOR and NRD.

These formulas consider the specific NRA associated with each tranche. Following the decisions of the Barber judgement, stated in Section 2, the NRA is 65 for men and 60 for women for tranche 1, 60 for both genders in the Barber Window (tranche 2), and 65 in the remaining tranches.

The revaluation rates ($r_i^{XS}(x)$ and $r_i^{GMP}(x)$) depend on the period of deferment x. In this type of revaluation method, the period of deferment is calculated in full years between DOL and the earlier of DOR and NRD for XS portion (Figure 4) and full tax years[8] between DOL and NRD for the GMP portion (Figure 5), taking into attention that if the date on which GMP can enter into payment (GMPD) equals DOR the last year of deferment will not be revalued.

---

[7] For the purpose of clarity and ease of explanation the non-linear benefits will be considered as XS. However, it is important to note that the scheme may establish distinct revaluation rules for these benefits.
[8] A full tax year is the period from 6 April of one year to 5 April of next year.
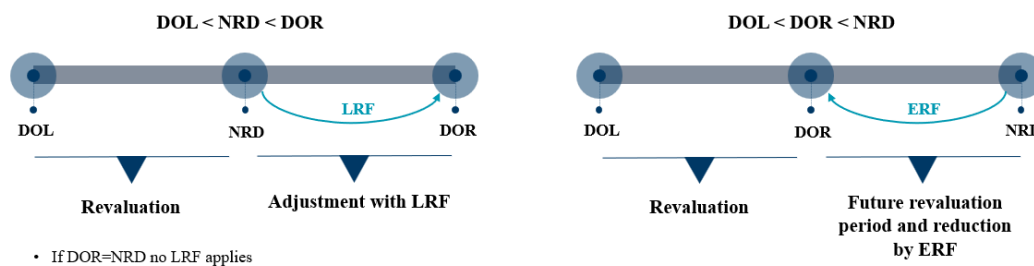
Figure 4. Possible scenarios for the XS Revaluation process.
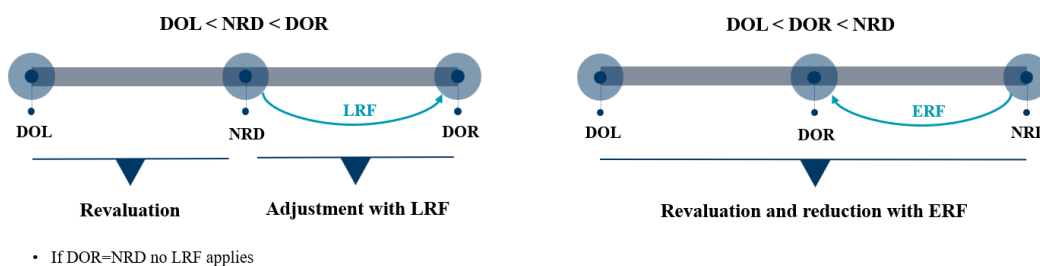
Figure 5. Possible scenarios for the GMP Revaluation process.

If the member retires after the NRD, the revaluation will be up to the NRD and then the pension will suffer an increase by a Late Retirement Factor (LRF). On the other hand, in cases of NRD after DOR, to penalise the member for retiring before NRD, an Early Retirement Factor (ERF) is applied considering the number of years from DOR to NRD. The Late and Early Retirement Factors are values defined by the scheme that consist of a certain amount depending on the number of years[9] (y) between NRD and DOR (Appendix 3).

In the NRD after DOR scenario, the retirement factor for the XS portion will be $RF_i^{XS}(y) = F^y * ERF(y)$, where F is the value of the Future revaluation rate provided by the scheme raised to the power of the number of complete years (y) from DOR to NRD in tranche i. This formula is applied for all tranches where GMPD≥NRD or GMPD>DOR.

For the tranches where DOR>GMPD and NRD>GMPD, the GMP will be calculated differently (Figure 6). This scenario happens for female members in tranche 3 where the NRA defined by the scheme is 65 but the GMPA defined by the state for women is 60.

---

[9] In cases where the period does not correspond to full years, an interpolation method is employed to calculate the proportional values.
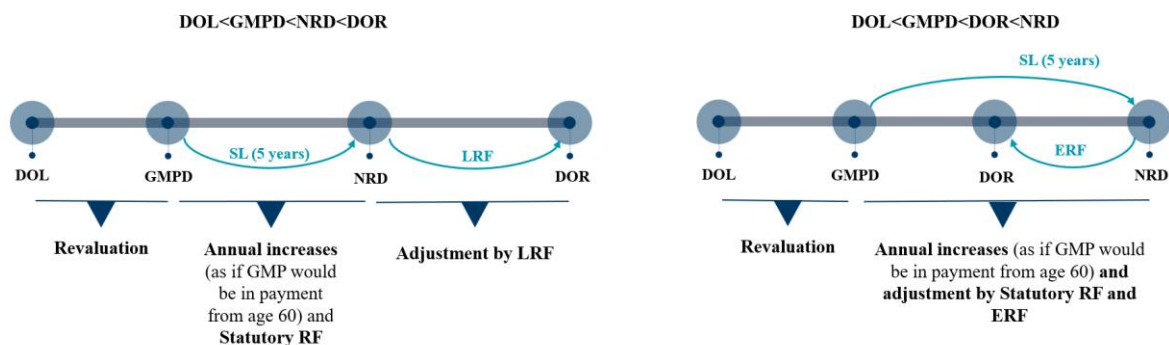
Figure 6. Possible scenarios for GMP Revaluation process if DOR>GMPD and NRD>GMPD.

In this case, the GMP at DOL will be revalued until GMPD and then applied a Statutory Late factor (SL_3) until NRD. This factor involves two components, the statutory retirement factor $\left(1 + \frac{w}{700}\right)$, where *w* is the number of weeks over GMPD, and the annual increases the member would miss from retiring at NRD instead of GMPD $(1 + m)$ (Appendix 4):

$$SL_3 = \left(1 + \frac{w}{700}\right) * (1 + m) \tag{7}$$

If the member retires after the NRD, a LRF will be applied. So, in this case $RF_3^{GMP}(y) = SL_3 * LRF(y)$. The other way, if the member retires before the NRD, the pension will be adjusted by an ERF, $RF_3^{GMP}(y) = SL_3 * ERF(y)$.

Depending on the method chosen by the scheme, the GMP revaluation rate ($r_i^{GMP}(x)$) can be achieved from one of the following processes:

Fixed rate revaluation – the rate is selected by crossing the member's DOL with the number of years in deferment (Appendix 5);

Section 148 revaluation - the rate is obtained by crossing the tax year of the DOL with the tax year on which the pension is being revalued (Appendix 6);

Limited rate revaluation – the rate is the lower between the 5% and the rate in Section 148 revaluation table.

Regarding the XS portion, the revaluation rate ($r_i^{XS}(x)$) is obtained by crossing the year to revalue (DOR or NRD) with the number of complete years of deferment between DOL and DOR or NRD, according to the method defined by the scheme:

Statutory uncapped – statutory revaluation based on RPI to 2011 and CPI thereafter with no cap applied (Appendix 7);

Statutory max 5% – statutory revaluation based on RPI to 2011 and CPI thereafter with max 5% per annum compound, generally applied before 6 April 2009;

Statutory max 2.5% – statutory revaluation based on RPI to 2011 and CPI thereafter with max 2.5% per annum compound, generally applied after 6 April 2009, inclusive;

RPI uncapped – revaluation based on RPI to previous September with no cap applied;

RPI max 5% – revaluation based on RPI to previous September with cap max 5% applied;

RPI max 2.5% – revaluation based on RPI to previous September with cap 2.5% applied.

The pension at DOR is initially referred to as the 'Pre-Commutation Pension' because members have the option to commute a portion of it, converting it into a lump-sum payment and consequently reducing the pension. After this, the pension is renamed 'Residual Pension'. After determining the Residual Pension, it is possible to determine how much the member's pension should increase as a result of the Equalisation process. The difference between the new Residual Pension and the old Residual Pension is called the 'uplift'. In the event that the Equalisation process does not lead to an increase in the member's pension, then this process will not continue, and the member's pension will remain the same.

As outlined in Section 2, the Equalisation process must be applied in the pension as a whole rather than each component. This distinction is crucial because the GMP legislation cannot be modified and therefore the values of this portion must remain intact. Thus, although the revaluation calculation is carried out tranche by tranche for XS and GMP, this only serves to obtain the final value of the revised Residual Pension (P_{DOR}^{new}) and, consequently, the uplift.

3.2.2. Indexation

The second stage of the Equalisation process is Indexation, which encompasses the application of annual increases in the Residual Pension at a specific day and month from the date of retirement to the current date. At this stage, the pension is no longer categorized into separate benefit components but is instead broken down into pension elements, each distinguished by its applicable rate and the start date for payment. The pension elements are generally divided as follows: Pre 88 GMP, Post 88 GMP, Pre 97 XS, Post 97 XS, and Post 2005 XS. Although the name of these elements can differ between schemes, it is easy to

understand at which period they belong, as shown in Table 7. Other non-linear elements can be added to the scheme, and they are either treated under the same conditions as the XS or with specific rules outlined by the scheme.

Table 7. Example list of pension elements.

Element name	Type
PRE 88 - GMP	Pre 88 GMP
Post 88 GMP (Witham) 3%/RPI	Post 88 GMP
Pre 97 XS 5% or RPI	Pre 97 XS
Pst 97 Pen 5% or RPI	Post 97 XS
POST 2005 CPI 5% MAX	Post 2005 XS
TEMP PEN 5%/RPI IF LOWER	Non-Linear

The initial step in Indexation involves a procedure referred to as 'Roll Back' (see Figure 7). This process takes the pension elements' current value ($E^{old}_{current,k}$) and removes the historical increases that have been applied successively until the retirement date to determine the pension elements that were put in payment at DOR ($E^{old}_{DOR,x}$):

$$E^{old}_{DOR,k} = E^{old}_{current,k} \prod_{i=0}^{m-1} \left(\frac{1}{1+r_{k,N-i}} \right) \tag{8}$$

where K is the number of elements in the scheme, $E^{old}_{current,k}$ is the value of the element k at the current date, with $k \in \{1, \dots, K\}$, and $r_{k,N-i}$ is the increase rate of the element k of the year N-i, with $i \in \{0, \dots, m-1\}$, being m the number of years from date of retirement to the last increase and N the date of the last increase.

	DOR			GMPD	Current Date
Roll Back	26/06/2020	01/04/2021	01/04/2022	01/04/2023	01/11/2023
PRE 88 - GMP	£ -	£ -	£ -	£ 1,728.00	£ 1,728.00
Post 88 GMP (Witham) 3%/RPI	£ -	£ -	£ -	£ 2,292.72	£ 2,292.72
Pre 97 XS 5% or RPI	£ 12,431.04	£ 12,567.84	£ 13,183.68	£ 9,691.20	£ 9,691.20
Pst 97 Pen 5% or RPI	£ 8,192.64	£ 8,282.76	£ 8,688.72	£ 9,123.24	£ 9,123.24
Total	£ 20,623.68	£ 20,850.60	£ 21,872.40	£ 22,835.16	£ 22,835.16

Figure 7. Example of the Roll Back process for a member with DOR at 26/06/2020, and fixed increase date on 1st April.

In addition to removing the increases from the current pension elements, it is also crucial to focus on the GMP and the date on which it becomes payable (GMPD). If GMPD is after DOR, from DOR to GMPD the total pre-97 pension put into payment will be treated as pre-97 XS, despite being the combination of XS and GMP, as shown in Table 8.

Table 8. Example of Rebalance for a member with GMPD after DOR.

Elements	Increase Before GMPD 01/04/2022	GMPD 26/06/2022	Increase after GMPD 01/04/2023
PRE 88 - GMP	£ -	£ 1,728.00	£ 1,728.00
Post 88 GMP (Witham) 3%/RPI	£ -	£ 2,226.00	£ 2,292.84
Pre 97 XS 5% or RPI	£ 13,183.68	£ 9,229.68	£ 9,691.20
Pst 97 Pen 5% or RPI	£ 8,688.72	£ 8,688.72	£ 9,123.24
Total	£ 21,872.40	£ 21,872.40	£ 22,835.16

At GMPD, the value of the GMP at GMPA in record (the statutory GMP) will be removed from the value of the pre-97 XS in payment on that date. At this point, the remaining pre-97 XS and the GMP will be put into payment separately. This step is called 'Rebalance' and must be taken into account in the Roll Back with each step taken in reverse order, *i.e.*, first the respective increase is removed from the value of each element and then the GMP element is combined with the pre-97 XS.

Moreover, if the value of the statutory GMP exceeds the value of the pre-97 pension, the entire GMP amount will be put into payment, and the pre-97 XS will be reduced to zero. This procedure, referred to as 'GMP Step up', ensures that the member retains the entitlement to the GMP, even if their contributions to the scheme were insufficient.

The main goal of the Roll Back is to determine the value of the elements of the Pension at DOR ($E_{DOR,k}^{old}$). Such values are then compared with the ones recorded in the system. If discrepancies emerge between these, it is advisable to prioritize the Roll Back values. Such disparities may arise due to rounding or input errors when entering the pension into the system. However, the current pension used for the Roll Back calculations is always reliable, and so is the result.

Since the Equalisation process specifically targets the pre-97 pension segment, it is designed to maintain the values of all other elements consistent with what was paid, apart from the pre-97 XS. Thus, the elements of the revised Pension at DOR will be those resulting from the Roll Back, with the exception of pre-97 XS, to which the uplift generated by the Revaluation stage and potentially rounding adjustments will be added (Table 9).

Table 9. Example of applying an uplift to the pre-97 XS of the old Pension at DOR resulted from the Roll Back process.

Old Residual Pension	£20,623.68
New Residual Pension	£22,220.09
Uplift	£1,596.41
Rounding[10]	£0.07

Old Pension at DOR	
PRE 88 - GMP	-
Post 88 GMP (Witham) 3%/RPI	-
Pre 97 XS 5% or RPI	£ 12,431.04
Pst 97 Pen 5% or RPI	£ 8,192.64
Total	**£ 20,623.68**

Revised Pension at DOR	
PRE 88 - GMP	-
Post 88 GMP (Witham) 3%/RPI	-
Pre 97 XS 5% or RPI	£ 12,431.04 + £1,596.41+ £0.07
Pst 97 Pen 5% or RPI	£ 8,192.64
Total	**£ 22,220.16**

The second step in Indexation is the Roll Forward, which receives as input the value of the Revised Pension at DOR elements. Roll Forward represents the reverse procedure of the Roll Back (see Figure 8). It involves the computation of the new value of the current elements in payment $\left(E^{new}_{current,k}\right)$, starting with the new elements of the Residual Pension $(E^{new}_{DOR,k})$, followed by the precise application of annual increases $(r_{k,y})$ to each element up to the current date:

$$E^{new}_{current,k} = E^{new}_{DOR,k} \prod_{y=n}^{N}(1 + r_{k,y}) \tag{9}$$

where K is the number of elements in the scheme, $E^{new}_{DOR,k}$ is the value of the element k at DOR, with $k \in \{1, ... \ K\}$, and $r_{k,y}$ is the increase rate of the element k of the year y, with $y \in \{n, ..., N\}$ being n the date of the first increase and N the date of the last increase.

Roll Forward	DOR 26/06/2020		01/04/2021		01/04/2022		GMPD 01/04/2023		Current Date 01/11/2023
PRE 88 - GMP	£	-	£	-	£	-	£ 1,728.00	£	1,728.00
Post 88 GMP (Witham) 3%/RPI	£	-	£	-	£	-	£ 2,292.84	£	2,292.84
Pre 97 XS 5% or RPI	£	14,027.52	£	14,181.84	£	14,876.76	£ 11,469.00	£	11,469.00
Pst 97 Pen 5% or RPI	£	8,192.64	£	8,282.76	£	8,688.72	£ 9,123.24	£	9,123.24
Total	£	22,220.16	£	22,464.60	£	23,565.48	£ 24,613.08	£	24,613.08

Figure 8. Example of the Roll Forward process for a member with DOR at 26/06/2020, and fixed increase date on 1st April.

---

[10] The total pension amount is required to be divisible by 12. If it does not meet this criterion, it may be necessary to increase the amount to ensure it.

The annual increases can be applied on a fixed date, such as every 1st of April, or on the DOR Anniversary, signifying the day and month the member retired. Furthermore, while the GMP increases are always full increases, the scheme has the discretion to determine if the first XS increase will be proportionate or full. A proportionate increase means that in the first year of retirement the pension is increased by a fraction or proportion of the increase rate corresponding to the period between the DOR and the first increase date.

As mentioned before, in the case of GMPD after DOR there is a need to conduct a Rebalance, as shown in Table 10. In that case, first separate the GMP from the XS and then increase each of the elements.

Table 10. Example of Rebalance for a member with GMPD after DOR.

Elements	Increase Before GMPD 01/04/2022		GMPD 26/06/2022		Increase after GMPD 01/04/2023	
PRE 88 - GMP	£	-	£	1,728.00	£	1,728.00
Post 88 GMP (Witham) 3%/RPI	£	-	£	2,226.00	£	2,292.84
Pre 97 XS 5% or RPI	£	14,876.76	£	10,922.76	£	11,469.00
Pst 97 Pen 5% or RPI	£	8,688.72	£	8,688.72	£	9,123.24
Total	£	23,565.48	£	23,565.48	£	24,613.08

The annual increases in both Roll Back and Roll Forward ($r_{k,y}$ and $r_{k,N-i}$) can follow CPI or RPI rates (Appendix 1) for the XS elements. These are based on a reference month and can be capped as the Table 11 below illustrates. For the GMP, schemes usually choose not to increase the pre-88 portion (as this is not mandatory) and increase the post-88 portion according to the table in Appendix 4, which is based on RPI rate until 2011 and CPI rate afterward with the September index.

Table 11. Example of Indexation rates applied to pension elements.

Element	Rate	Reference month	Min	Max
Pre 88 - GMP	Nil	-	-	-
Post 88 GMP (Witham) 3%/RPI	RPI/CPI	September	0%	3%
Pre 97 XS 5% or RPI	RPI	September	0%	5%
Pst 97 Pen 5% or RPI	RPI	September	0%	5%

This stage also entails the provision of arrears (the difference between the new pension revised and the old pension the member received), covering the duration from their retirement to the present moment. This approach ensures that pensioners receive the appropriate pension amounts and rectifies any discrepancies that may have arisen over time. To compensate for the

late payment of the arrears, the scheme can also decide to pay interest, as explained in Section 2.

4. Results

This section marks a critical point in the study, revealing the practical implementation of the methodology described. Two calculators, meticulously designed and methodically explained in the preceding section, take centre stage. These calculators, which represent a paradigm shift in automation through VBA, encapsulate the fundamental rules of their respective processes. Their design ensures consistent results and offers a level of flexibility that allows for manual adjustments of specific rules. Throughout this section, there will be a detailed step-by-step presentation of these calculators and their outcomes, highlighting their efficiency and adaptability.

4.1. Retranching Calculator

The Retranching calculator consists of a Microsoft Excel file with 4 main spreadsheets: *Instructions*, *Cover*, *Input*, and *Template*. In addition to these, there is also an auxiliary spreadsheet named *Support* (Figure 9).
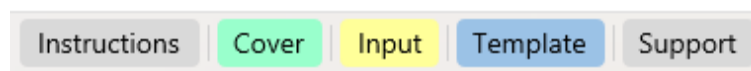
Figure 9. Spreadsheets of the Retranching calculator.

Before going through the calculator itself, it is important to understand how to work with it. The *Instructions* spreadsheet offers a step-by-step procedure and some notes to take into account before running the calculator. On the *Cover* tab, there is a menu with 8 buttons assigned to Macros (Figure 10), that will take part in the process of filling the calculator and producing the results.

The first button (Extract data) allows to select the data file and import only the relevant spreadsheets (indicated by the user in the *Support* spreadsheet). With the data at hand, the next step is to insert the ID number of all members to analyse in the *Input* spreadsheet and click on the second button (Fill Cover and Input) to collect all the information associated with them[11]. Such information includes basic details (name, sex, DOB, DCPS, DOL, …), non-linear indicators (Part-Time activity, Transfer-Ins, …), and the tranches and benefit components' amounts, and it will be automatically written on the *Input* spreadsheet. This macro also pulls the scheme tranches and benefit components to the *Cover* spreadsheet (see left side of Figure

---

[11] This allows to filter the database to gather only the information about the members to analyse.

13), so the Macros can read it later to carry out the Retranching. The structure of the tranches and BCs are the same for all members selected.

Figure 10. Menu with 8 buttons to run through the Retranching process.

Before proceeding to the Retranching, it is necessary to select the approach to carry out between the three possible cases (Figure 10) and fill in other information that will be important for the final phase of the project, such as the equalisation date and the structure of the new tranches and benefit components.

To ensure that all relevant data fields are filled, all manual input fields are distinctly marked with a light-yellow background, as the Retranching approach options in Figure 10. The completion of all these indicated fields enables the activation of the 'Validation' button. Upon pressing this button, a red checkmark appears in the box next to it, indicating readiness to proceed with the subsequent stages of the process, as shown in Figure 11. If not, the user will receive a message indicating the field to be filled in (Figure 12).
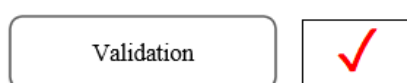
Figure 11. Checkmark after validating that all required fields are filled.
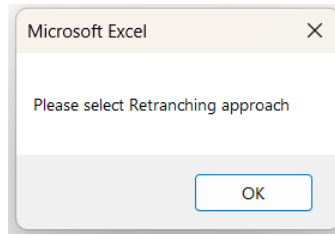
Figure 12. Pop-up message indicating the unfilled field.

Pressing the fourth button (Fill Template) will fill the *Template* spreadsheet according to the information in the *Cover* spreadsheet and the type of Retranching process selected (Figure 13).

Original Pension at DOL				
Tranche	Code	Component		Amount
0	1	Pre 88 GMP	£	-
0	2	Post 88 GMP	£	-
0	10	Non Revaluing Pension 1	£	-
0	15	Revaluing Excess Pension 1	£	-
4	15	Revaluing Excess Pension 1	£	-
5	15	Revaluing Excess Pension 1	£	-
7	15	Revaluing Excess Pension 1	£	-
99	33	Scale Pension	£	-
		Total	£	-
		Check	£	-

Revised Pension at DOL				
Tranche	Code	Component		Amount
1	1	Pre 88 GMP	£	-
1	2	Post 88 GMP	£	-
1	10	Non Revaluing Pension 1	£	-
1	15	Revaluing Excess Pension 1	£	-
2	2	Post 88 GMP	£	-
2	10	Non Revaluing Pension 1	£	-
2	15	Revaluing Excess Pension 1	£	-
3	2	Post 88 GMP	£	-
3	15	Revaluing Excess Pension 1	£	-
4	15	Revaluing Excess Pension 1	£	-
5	15	Revaluing Excess Pension 1	£	-
7	15	Revaluing Excess Pension 1	£	-
99	33	Scale Pension	£	-
		Old Scale Pension	£	-
		Check	£	-

Figure 13. Result of the 'Fill Template' button with the old structure of the tranches and benefit components on the left side and the new structure on the right side.

The *Template* spreadsheet is designed to be universal, working for all members of the group mentioned in the *Input* spreadsheet. However, at this stage, it is now possible to obtain the specific information for each particular member belonging to that group. To that end, the user must enter the member's ID in the designated cell (Figure 14).

ID	19710
NINO	AA123456Y
Surname	SMITH
Sex	F
Class	LPC-DB-BASIS
DOB	28/09/1958
DCPS	01/01/1987
DOL	31/05/1994
Service Calculation	Months

Figure 14. Field to input the member's ID (first cell), basic details, and, at the bottom, a drop-down list to select the type of service calculation.

The *Template* spreadsheet will then automatically calculate the pension for the respective member, demonstrating the old pension distribution and the new one (Figure 15).

Original Pension at DOL				
Tranche	Code	Component		Amount
0	1	Pre 88 GMP	£	106.08
0	2	Post 88 GMP	£	411.32
0	10	Non Revaluing Pension 1	£	-
0	15	Revaluing Excess Pension 1	£	1,168.92
4	15	Revaluing Excess Pension 1	£	-
5	15	Revaluing Excess Pension 1	£	-
7	15	Revaluing Excess Pension 1	£	-
99	33	Scale Pension	£	1,686.32
		Total	£	1,686.32
		Check	£	-

Revised Pension at DOL				
Tranche	Code	Component		Amount
1	1	Pre 88 GMP	£	106.08
1	2	Post 88 GMP	£	141.13
1	10	Non Revaluing Pension 1	£	-
1	15	Revaluing Excess Pension 1	£	538.49
2	2	Post 88 GMP	£	242.55
2	10	Non Revaluing Pension 1	£	-
2	15	Revaluing Excess Pension 1	£	564.76
3	2	Post 88 GMP	£	27.64
3	15	Revaluing Excess Pension 1	£	65.67
4	15	Revaluing Excess Pension 1	£	-
5	15	Revaluing Excess Pension 1	£	-
7	15	Revaluing Excess Pension 1	£	-
99	33	Scale Pension	£	1,686.32
		Old Scale Pension	£	1,686.32
		Check	£	-

Figure 15. Result after the Retranching calculator with the original pension distribution on the left side and the revised pension at DOL distribution on the right side.

Given the considerable volume of members requiring rectification in these projects, the fifth button (Output) is instrumental in generating a new spreadsheet named *Output*. This spreadsheet compiles the outcomes of the Retranching process for each member. The associated macro efficiently processes each member's data through the *Template* spreadsheet by inputting the ID number, incorporating the resulting values into the *Output* spreadsheet, and repeating this process for all members in a sequential manner. This approach ensures that the process is executed efficiently and uniformly across all members. Additionally, any necessary adjustments to the *Template* can be made once, propagating the corrections to all members seamlessly.

The *Output* spreadsheet also includes two additional functionalities that can be used after the output is generated, as shown in Figure 16.

<div align="center">

Export Individual   Update Output

</div>

Figure 16. Two buttons on the Output spreadsheet: the first exports an individual spreadsheet and the second updates the values on the Output spreadsheet.

The first one allows to export an individual spreadsheet replicating the *Template* for a single member by selecting it and clicking the button (Export Individual). This proved to be especially useful for cases where specific member characteristics necessitate the application of distinct rules within the *Template*. The second button (Update Output) serves to update the

Output spreadsheet with the new values whenever modifications are made to the *Template* or individual spreadsheets are exported.

It is crucial to emphasize that in case an individual calculation has been exported for a certain member, the macro will read the results from the corresponding individual spreadsheet and not from the *Template* spreadsheet. This integration ensures that the *Output* spreadsheet remains up to date with the latest changes made with just one click.

After confirming the accuracy of calculations and ensuring no further adjustments are needed, the sixth button (Export Summary File) initiates the creation of a new file, the *Summary file*, in the same folder as the calculator. This encompasses all member information along with the results of the Retranching process, consolidating the data for peer review.

The final step involves the creation of the *Load file* by clicking the seventh button (Create Load File). This file incorporates comprehensive project information, dedicating a row to each benefit component for every member. It includes various essential details, such as the revaluation rate of each benefit and the respective escalations. Activation of the eighth button (Export Load File) triggers the macro to duplicate this spreadsheet, export it to a separate file containing only paste values (no formulas), and securely save it within the same folder as the calculator.

4.2. Equalisation Calculator

The Equalisation calculator is built on the same principles as the Retranching one. It consists of a Microsoft Excel file with 4 main spreadsheets: *Instructions*, *Cover*, *Input*, and *Template*, and, in addition to these, there are also auxiliary spreadsheets containing the revaluation tables, retirement factors, increase rates, interest rates, and so on.

The first spreadsheet contains the using instructions and some notes regarding the methodology behind the calculator, the limitations, and how to adjust the calculator for specific rules. On the *Cover* spreadsheet, there is a new menu with 10 buttons assigned to Macros, as shown in Figure 17.

1. Extract data	**Steps:** Open the File Explorer, select the DGA file and import selected spreadsheets.
2. Fill Cover	**Steps:** Fill Cover with Tranches & Benefit Components and Pension Elements.
3. Fill Input	**Steps:** Fill Input with necessary members' data.
4. Validation	
5. Fill Template	**Steps:** Complete the Template.
6. Import Interests	**Steps:** If necessary, import interest rates from 'Interest Tool'.
7. Output	**Steps:** Run all members in scope.
8. Summary File	**Steps:** Export Summary File in a different workbook with Basic Details and New Pension Elements.
9. Create Load File	**Steps:** Create Load File.
10. Export Load File	**Steps:** Export Load File in a different workbook.

Figure 17. Menu with 10 buttons to run through the Equalisation process.

The initial steps are similar to the previous calculator, from importing the relevant data through the first button (Extract data) to inserting the ID of all members to analyse in the *Input* spreadsheet. After clicking on the second button (Fill Cover), the *Cover* spreadsheet will pull the scheme tranches and benefit components and the pension elements. To enable the *Template*'s functionalities, it is necessary to have a chronological order of the pension elements, namely: Pre 88 GMP, Post 88 GMP, Pre 97 XS, Post 97 XS, and so on. Given the diversity of element names between schemes, the user must do this step manually.

Then, proceed with the third button (Fill Input) to collect in the *Input* spreadsheet all the information regarding basic details, non-linear indicators, tranches and benefit components' amounts, GMP details, Pre-Commutation Pension, Pension Commuted, Residual Pension, and original and current pension elements' amounts.

The fourth button (Validation) ensures that all fields regarding rules and characteristics of the scheme are filled in, such as the tranches' date ranges, tranches' NRDs, tranches' revaluation rates for XS, GMP revaluation rate (Figure 18), pension elements increase date, applicable rates, minimum and maximum rates, and reference month (Figure 19).

Tranches	Start Date	End Date	NRD Females	NRD Males	XS Reval
1	DCPS	16/05/1990	60	65	RPI max 5%
2	17/05/1990	31/07/1994	60	60	RPI max 5%
3	01/08/1994	05/04/1997	65	65	RPI max 5%
4	06/04/1997	05/04/2005	65	65	RPI max 5%
5	06/04/2005	05/04/2014	65	65	RPI max 5%
7	06/04/2014	DOL	65	65	RPI max 2.5%

GMP Reval
Fixed rate

Figure 18. Fields to be filled (highlighted in yellow) regarding tranches' information and GMP revaluation.

Increase date type	Increase Day	Increase Month
Fixed date	1	4

Pension Elements		Please order the elements: Pre 88 GMP, Post 88 GMP, Pre 97 XS and so on			
Pen Elm Code	Pen Elm Decode	Reference Month	RPI/CPI	Min	Max
111	PRE 88 - GMP	-	-	-	-
869	Post 88 GMP (Witham) 3%/RPI	9	RPI/CPI	0.00%	3.00%
958	Pre 97 XS 5% or RPI	9	RPI	0.00%	5.00%
889	Pst 97 Pen 5% or RPI	9	RPI	0.00%	5.00%
2005	TEMP PEN 5%/RPI IF LOWER	9	RPI	0.00%	5.00%

Figure 19. Fields to be filled (highlighted in yellow) regarding pension elements' increases information, and a note reminding the user to order the elements.

After validation, proceed to the next button (Fill Template) that will complete the information on the *Template* spreadsheet, filling it with the basic details (Figure 20), tranches and benefit components, pension elements, and so on (Figure 21).

ID	3560
NINO	AA123456X
PPN	3560
Surname	JONES
SEX	M
DOB	27/01/1956
DCPS	27/01/1976
DJS	27/01/1976
Service Start Date	27/01/1976
DOL	31/08/2012
DOR	31/01/2019
GMPD	27/01/2021
Age at DOR	63
Class	C 1/80TH MEMBER
Non Linear	N

Revaluation	
New Equalisation Date	31/07/1994
Revaluation Type	NRD
NRA	60
NRD 60	27/01/2016
NRA	65
NRD 65	27/01/2021
Indexation	
Calculation Date	01/11/2023
Increase date type	Fixed date
Increase Day	1
Increase Month	4
Non-GMP 1st increase	01/04/2019
GMP 1st increase	01/04/2021
XS Increase Type	Full
GMP Increase Type	Full
DOR after GMPA	N

Figure 20. The first table englobes a field to input the member's ID (first cell) and is then filled with some basic details. The Second table includes Revaluation and Indexation information.

Pension at DOL				
Tranche	Code	Benefit Component		Amount
1	1	Pre 88 GMP	£	1,361.88
1	2	Post 88 GMP	£	229.08
1	15	Revaluing Excess Pension 1	£	4,106.84
2	2	Post 88 GMP	£	131.03
2	15	Revaluing Excess Pension 1	£	413.75
3	2	Post 88 GMP	£	615.93
3	15	Revaluing Excess Pension 1	£	1,944.90
4	15	Revaluing Excess Pension 1	£	3,528.08
5	15	Revaluing Excess Pension 1	£	1,822.11
5	5	Transfer In Excess 1	£	3,148.28
99	33	Scale Pension	£	17,301.88

Pension at DOR		
Gross Pension	£	16,835.88
Pension Commuted	£	5,544.00
Cash Gross Amount	£	75,398.62
Residual Pension	£	11,291.88

Pension Elements - 2023						
Element		Current Amount		Original Amount	Start Date	Next Increase
PRE 88 - GMP	£	1,847.52	£	-	19/11/2020	
Post 88 GMP (Witham) 3%/RPI	£	1,306.92	£	-	19/11/2020	01/04/2024
Pre 97 XS 5% or RPI	£	4,319.64	£	7,161.55	31/01/2019	01/04/2024
Pst 97 Pen 5% or RPI	£	5,669.64	£	4,148.33	31/01/2019	01/04/2024
Total	£	13,143.72	£	11,309.88		01/04/2024

Figure 21. Example of scheme information presented in the Template spreadsheet.

For the Revaluation process, the *Template* combines all the information needed to calculate the pension correctly, as shown in Figure 22.

	XS Revaluation			XS Future Revaluation		GMP Revaluation		
Tranche	NRD/DOR	Years deferment	Revaluation Rate	Years deferment	Revaluation Rate	NRD/DOR	Years deferment	Revaluation Rate
1	DOR	6	1.165	2	1.049	65	7	1.384
2	60	3	1.064	0	1.000	60	3	1.149
3	DOR	6	1.165	2	1.049	65	7	1.384
4	DOR	6	1.165	2	1.049	-	-	-
5	DOR	6	1.165	2	1.049	-	-	-
7	DOR	6	1.160	2	1.049	-	-	-

Late or Early Scheme Retirement Factors					
NRA	Type	Years late/early	Months late/early	LRF	ERF
65	Early Retirement	1	11	1	0.929916667
60	Late Retirement	3	0	1.213	1
65	Early Retirement	1	11	1	0.929916667

DOR before GMPA	Statutory Late			Late Scheme Retirement Factor		
Nº weeks over GMPA	Pre 88 GMP	Post 88 GMP	Over 65 age?	Years late	Months late	LRF
			N			1

Pre-Commutation Pension Calculation									
Tranche	Element	Value		Revaluation	Pension at NRA		LRF / ERF	Pre-commutation Pension	
1	Pre 88 GMP	£	1,361.88	1.384	£	1,884.57	0.930	£	1,752.49
	Post 88 GMP	£	229.08	1.384	£	317.00	0.930	£	294.78
	XS Pension	£	4,106.84	1.222	£	5,016.88	0.930	£	4,665.28
2	Post 88 GMP	£	131.03	1.149	£	150.61	1.213	£	182.68
	XS Pension	£	413.75	1.064	£	440.23	1.213	£	534.00
3	Post 88 GMP	£	615.93	1.384	£	852.32	0.930	£	792.59
	XS Pension	£	1,944.90	1.222	£	2,375.87	0.930	£	2,209.36
4	XS Pension	£	3,528.08	1.222	£	4,309.87	0.930	£	4,007.82
5	XS Pension	£	4,970.39	1.222	£	6,071.78	0.930	£	5,646.25
7	XS Pension	£	-					£	-
Total		£	17,301.88					£	20,085.27

Figure 22. Revaluation calculation.

Each step of the Equalisation process will be performed as specified in Section 3. Therefore, for the Indexation process, the *Template* proceeds to calculate the Pension at DOR through the Roll Back and the current pension value through the Roll Forward, with the Roll Back values and the uplift added (Figure 23).

Equalisation result			Roll Back Pension at DOR			add Uplift	Revised Pension at DOR		
Pre Commutation Pension	£ 20,085.27		PRE 88 - GMP	£	-	-	PRE 88 - GMP	£	-
Residual Pension	£ 14,541.27		Post 88 GMP (Witham) 3%/RPI	£	-	-	Post 88 GMP (Witham) 3%/RPI	£	-
Rounding	£ 0.09		Pre 97 XS 5% or RPI	£	6,572.28	£ 3,156.00	Pre 97 XS 5% or RPI	£	9,728.28
			Pst 97 Pen 5% or RPI	£	4,813.08	£ -	Pst 97 Pen 5% or RPI	£	4,813.08
Uplift	£ 3,155.91		Total		£ 11,385.36		Total		£ 14,541.36

	DOR			GMPD			Current date
Roll Back	31/01/2019	01/04/2019	01/04/2020	01/04/2021	01/04/2022	01/04/2023	01/11/2023
PRE 88 - GMP	£ -	£ -	£ -	£ 1,847.52	£ 1,847.52	£ 1,847.52	£ 1,847.52
Post 88 GMP (Witham) 3%/RPI	£ -	£ -	£ -	£ 1,231.92	£ 1,268.88	£ 1,306.92	£ 1,306.92
Pre 97 XS 5% or RPI	£ 6,572.28	£ 6,789.24	£ 6,952.20	£ 3,921.60	£ 4,113.84	£ 4,319.64	£ 4,319.64
Pst 97 Pen 5% or RPI	£ 4,813.08	£ 4,971.96	£ 5,091.36	£ 5,147.40	£ 5,399.64	£ 5,669.64	£ 5,669.64
Total	£ 11,385.36	£ 11,761.20	£ 12,043.56	£ 12,148.44	£ 12,629.88	£ 13,143.72	£ 13,143.72

	DOR			GMPD			Current date
Roll Forward	31/01/2019	01/04/2019	01/04/2020	01/04/2021	01/04/2022	01/04/2023	01/11/2023
PRE 88 - GMP	£ -	£ -	£ -	£ 1,847.52	£ 1,847.52	£ 1,847.52	£ 1,847.52
Post 88 GMP (Witham) 3%/RPI	£ -	£ -	£ -	£ 1,231.92	£ 1,268.88	£ 1,306.92	£ 1,306.92
Pre 97 XS 5% or RPI	£ 9,728.28	£ 10,049.40	£ 10,290.60	£ 7,296.72	£ 7,654.32	£ 8,037.12	£ 8,037.12
Pst 97 Pen 5% or RPI	£ 4,813.08	£ 4,971.96	£ 5,091.36	£ 5,147.40	£ 5,399.64	£ 5,669.64	£ 5,669.64
Total	£ 14,541.36	£ 15,021.36	£ 15,381.96	£ 15,523.56	£ 16,170.36	£ 16,861.20	£ 16,861.20

Nº of Payments	2	12	12	12	12	7	0
Arrears							
New	£ 2,423.56	£ 15,021.36	£ 15,381.96	£ 15,523.56	£ 16,170.36	£ 9,835.70	£ -
Old	£ 1,897.56	£ 11,761.20	£ 12,043.56	£ 12,148.44	£ 12,629.88	£ 7,667.17	£ -
Difference	£ 526.00	£ 3,260.16	£ 3,338.40	£ 3,375.12	£ 3,540.48	£ 2,168.53	£ -
Interest Rate	0%	0%	0%	0%	0%	0%	0%
Interest Amount	£ -	£ -	£ -	£ -	£ -	£ -	£ -

Figure 23. Roll Back and Roll Forward processes and arrears calculations without interest.

The sixth button (Import Interest) is only required if the scheme decides to apply interest on the arrears. In that case, pressing this button opens another file designed to calculate interest and import the values. These values are pulled into the *Template* through formulas.

If required, all formulas within the *Template* can be modified, and additional rows can be added. The Macros will execute correctly as long as the cells remain in their respective columns. If the calculator aligns with all the rules outlined in the scheme, and no adjustments are necessary or if these have already been made, it is time to proceed to the next step.

The seventh button (Output) works similarly to the one in the Retranching calculator. It generates a new spreadsheet titled *Output* and processes members one by one through the

Template to systematically introduce the results regarding old and new Residual Pensions and pension elements. Additionally, this spreadsheet also includes the functionalities of 'Export Individual' and 'Update Output', as in the Retranching calculator.

Finalised the analysis and adjustments, it remains to export the *Summary file* and, after peer review and approval, create (Create Load File) and export (Export Load File) the file with all the information to send to the team that will implement the values of the new equalised pension in the system.

5. Conclusion

The United Kingdom's pension system has undergone a dynamic evolution, characterized by shifting policies and regulations aimed at ensuring fairness and equity among pension beneficiaries. Central to this transformation has been the imperative of equalising pension benefits, especially in the context of gender disparities. The pension equalisation process has led to a significant need for pension rectification, as pension schemes have undergone rule changes. This rectification is a complex and extensive process that spans thousands of schemes.

Given the constant and repetitive nature of this need, it is feasible to develop a calculator that automates most of the process. In this project, two calculators were developed for a global consulting company. The Retranching calculator distributes the members' deferred pension in tranches according to the new scheme rules. This calculator allows distribution based on 3 different approaches that can be combined with each other or used separately. The Equalisation calculator carries out two processes: the Revaluation process up to NRD based on the Barber judgement, which revalues the overall pension to figure out the uplift that should be given to the pension at DOR; and the Indexation process, which not only protects the value of a member's pension against inflation by applying annual increases, but also guarantees the payment of the difference between the pension paid and the new pension each year from DOR to the current date (arrears).

Going beyond the automation of the most repetitive and mechanical tasks, such as data retrieval, organisation, and formulas writing, these calculators significantly reduce the likelihood of human error due to distraction, formula misunderstanding, or lack of knowledge. It also provides adaptability, as the calculator can be adapted to specific information for different members or different rule schemes, without compromising its functionality. The most significant aspect is the uniformity of the process, as now each type of rectification process has a base calculator to ensure consistency and allow all teams (Portugal, UK, and India) to use the same tool. This facilitates the peer review process, as all colleagues become familiar with the methodology and layout of these calculators. Standardisation contributes to more efficient and reliable execution of the pension Equalisation process, promoting a consistent and robust approach across the board. Additionally, this project has clarified in detail how to perform these processes.

With these calculators, the time required to complete a Retranching project is reduced by approximately 15 hours, and an Equalisation project is completed in about 20 hours less compared to completing these projects without the aid of the calculators. Furthermore, beyond the time saved during the actual project execution, it is essential to highlight the efficiency gained in the project review process. Familiarity with the template structure reduces the time needed to understand the calculator and allows for quicker and more accurate identification of components and potential errors, leaving more time for in-depth analysis and contributing to an overall increase in productivity and effectiveness.

While many projects involve substantial amounts of data that can make them computationally intensive, the VBA Macros have been meticulously coded to optimize efficiency. This optimization ensures that the Macros run swiftly, significantly reducing the time required for processing and analysis. The careful programming allows for smoother execution even with large datasets, enhancing the overall performance and responsiveness of the system.

One of the most important features of this project is that once the calculators were completed, they were validated by senior members of the team (Portugal and UK) to ensure that all the requirements were met so that we could put the calculator into practice. Looking ahead, there are promising opportunities for enhancing the performance and versatility of the calculators designed. By embracing a continuous improvement mindset, the goal is to refine these tools to further optimize their functionality and adaptability in complex pension scenarios. Several areas of focus for potential enhancements include projects with an equalisation date after 1997, diversified revaluation processes, and, importantly, incorporating user feedback to rectify and improve functionalities.

References

Attanasio, O. P. & Rohwedder, S., 2003. Pension Wealth and Household Saving: Evidence from Pension Reforms in the United Kingdom. *American Economic Review,* 93(5), pp. 1499-1521.

Banks, J. & Emmerson, C., 2018. *A Lifetime of changes: State Pensions and Work Incentives at older ages in the UK, 1948-2018,* Cambridge: National Bureau of Economic Research.

Banks, J., Emmerson, C. & Tetlow, G., 2016. Long-run Trends in the Economic Activity of Older People in the United Kingdom. In: D. A. Wise, ed. *Social Security Programs and Retirement around the World: Working Longer.* Chicago: University of Chicago Press, pp. 267-297.

Banks, J. & Smith, S., 2006. Retirement in the UK. *Oxford Review of Economic Policy,* 22(1), pp. 40-56.

Blake, D., 2000. Two decades of pension reform in the UK. *Employee Relations,* 22(3), pp. 223-245.

Bozio, A., Crawford, R. & Tetlow, G., 2010. *The history of state pensions in the UK: 1948 to 2010,* London: The Institute for Fiscal Studies.

Crawford, R., Keynes, S. & Tetlow, G., 2013. *A single-tier pension: what does it really mean?,* London: The Institute for Fiscal Studies.

Davis, E. P., 1993. *The structure, regulation, and performance of pension funds in nine industrial countries,* Washington: The Worl Bank Publications.

Daykin CB, C. et al., 2002. Contracting-Out in the United Kingdom. *Journal of Aging & Social Policy,* 14(1), pp. 23-34.

Department for Work & Pensions, 2010. Consultation on Government proposals. *The impact of using CPI as the measure of price increases on private sector occupational pension schemes*, December.

Department for Work & Pensions, 2011. *Impact of the move to CPI for Occupational Pensions,* London: House of Commons.

Department for Work & Pensions, 2013. *Pensions the Basics,* London: Crown.

Department for Work & Pensions, 2019. *Guidance on the use of the Guaranteed Minimum Pensions (GMP) conversion legislation,* London: Crown.

Department of Health Social Security, 1978. *New Pensions: A more secure future,* Richmond: The National Archives.

Disney, R., 1995. *Occupational Pension Schemes: Prospects and Reforms in the UK,* London: The Institute for Fiscal Studies.

Fitzpatrick, B., 1991. Equality in Occupational Pensions. The New Frontiers after Barber. *The Modern Law Review,* 54(2), pp. 271-280.

Harrison, D. & Blake, D. P., 2013. *A Healthier Way to De-Risk: The Introduction of Medical Underwriting to the Defined Benefit De-Risking Market,* London: The Pensions Institute.

HC Deb, 2014. Hansard. 6 January, Volume 573, cols 51W.

HM Revenue & Customs, 2022. *Pension schemes newletter 140,* London: Crown.

James, P., 2002. Guaranteed minimum pensions – Equalisation. *Pensions: An International Journal ,* 8(1), pp. 32-40.

Mayhew, L., 2001. *A Comparative Analysis of the UK Pension System Including the Views of Ten Pension Experts,* s.l.: PEN-REF Project Deliverable D2.

Moffat, G. & Luckhaus, L., 1998. Occupational pension schemes, equality and Europe: A decade of change. *Journal of Social Welfare and Family Law,* 20(1), pp. 1-22.

National Audit Office, 2016. *The impact of state pension reforms on people with Guaranteed Minimum Pensions,* London: House of Commons.

New Law Journal, 2020. Pensions. *Closing The Pensions Window*, 17 Julho, 170(7895).

Thurley, D., 2012. *Occupational pension increases,* London: House of Commons.

Thurley, D., 2014. *Guaranteed Minimum Pensions – annual increases,* London: House of Commons.

Thurley, D., 2021. *GMP Equalisation,* London: House of Commons.

UK Parliament, 1995. *Pensions Act 1995,* London: House of Commons.

Appendix

Appendix 1 – CPI and RPI rates from 1980 to 2022 based on September index

Year	CPI	RPI
1980	-	15,90%
1981	-	11,40%
1982	-	7,30%
1983	-	6,80%
1984	-	6,30%
1985	-	5,40%
1986	-	4,90%
1987	-	5,30%
1988	-	4,60%
1989	5,20%	4,00%
1990	8,10%	3,70%
1991	7,10%	3,70%
1992	3,00%	4,20%
1993	3,10%	4,60%
1994	1,50%	5,10%
1995	3,00%	5,00%
1996	2,30%	4,80%
1997	1,80%	5,30%
1998	1,40%	5,10%
1999	1,20%	5,10%
2000	1,00%	5,20%
2001	1,30%	5,20%
2002	1,00%	5,10%
2003	1,40%	5,10%
2004	1,10%	4,50%
2005	2,50%	5,00%
2006	2,40%	4,70%
2007	1,80%	5,00%
2008	5,20%	4,90%
2009	1,10%	4,60%
2010	3,10%	5,00%
2011	5,20%	5,40%
2012	2,20%	6,10%
2013	2,70%	6,90%
2014	1,20%	7,00%
2015	-0,10%	7,00%
2016	1,00%	6,90%
2017	3,00%	6,20%
2018	2,40%	5,90%
2019	1,70%	5,40%
2020	0,50%	5,50%
2021	3,10%	5,70%
2022	10,10%	5,50%

Appendix 1 – CPI and RPI rates from 1980 to 2022 based on September index

Appendix 2 – List of Benefit Components

Benefit Component Code	Benefit Component description
1	Pre 88 GMP
2	Post 88 GMP
3	Transfer In Pre 88 GMP
4	Transfer In Post 88 GMP
5	Transfer In Excess 1
6	Transfer In Excess 2
7	AVC Pension 1
8	AVC Pension 2
9	AVC Pension 3
10	Non Revaluing Pension 1
11	Non Revaluing Pension 2
12	Non Revaluing Pension 3
13	Non Revaluing Pension 4
14	Non Revaluing Pension 5
15	Revaluing Excess Pension 1
16	Revaluing Excess Pension 2
17	Revaluing Excess Pension 3
18	Revaluing Excess Pension 4
19	Revaluing Excess Pension 5
20	Revaluing Excess Pension 6
21	Revaluing Excess Pension 7
22	Revaluing Excess Pension 8
23	Revaluing Excess Pension 9
24	StepUp Pension 1
25	StepUp Pension 2
26	StepUp Pension 3
27	Bridging Pension 1
28	Bridging Pension 2
29	Bridging Pension 3
30	Insured Pension
31	Non Revaluing Optional Cash
32	Non Revaluing Additional Cash
33	Scale Pension
34	Scale Optional Cash
35	Scale Additional Cash
36	Revaluing Scale Pension
37	Revaluing Optional Cash
38	Revaluing Additional Cash
39	NRD Pension
40	NRD Optional Cash
41	NRD Additional Cash
42	Lump Sum Death Benefit
43	Requisite Benefit
44	Transfer In Optional Cash
45	Transfer In Additional Cash
46	AVC Cash
47	Non Revaluing Scale Pension
48	Benefit Gtee Lump Sum

Appendix 3 - Example of a Late and Early Retirement Factors Table

Number of years early/late	ERF	LRF
0	1.000	1.000
1	0.962	1.065
2	0.927	1.136
3	0.894	1.213
4	0.863	1.297
5	0.833	1.387
6	0.805	1.486
7	0.779	1.594
8	0.755	1.712
9	0.731	1.840
10	0.709	1.980

Appendix 4 - Increases on Post 05/04/1988 GMP – under Section 109 of the Pension Schemes Act 1993 ("Section 37A Orders")

Year	GMP Increase
1990	3.00%
1991	3.00%
1992	3.00%
1993	3.00%
1994	1.80%
1995	2.20%
1996	3.00%
1997	2.10%
1998	3.00%
1999	3.00%
2000	1.10%
2001	3.00%
2002	1.70%
2003	1.70%
2004	2.80%
2005	3.00%
2006	2.70%
2007	3.00%
2008	3.00%
2009	3.00%
2010	0.00%
2011	3.00%
2012	3.00%
2013	2.20%
2014	2.70%
2015	1.20%
2016	0.00%
2017	1.00%
2018	3.00%
2019	2.40%
2020	1.70%
2021	0.50%
2022	3.00%
2023	3.00%

Appendix 5 - Fixed Revaluation Rate for GMP

	DOL								
	06/04/2022	06/04/2017	06/04/2012	06/04/2007	06/04/2002	06/04/1997	06/04/1993	06/04/1988	
	05/04/2022	05/04/2017	05/04/2012	05/04/2007	05/04/2002	05/04/1997	05/04/1993	06/04/1988	06/04/1988
0	1.0000	1.000	1.0000	1.000	1.000	1.0000	1.000	1.000	1.000
1	1.0325	1.035	1.0475	1.040	1.045	1.0625	1.070	1.075	1.085
2	1.0661	1.071	1.0973	1.082	1.092	1.1289	1.145	1.156	1.177
3	1.1007	1.109	1.1494	1.125	1.141	1.1995	1.225	1.242	1.277
4	1.1365	1.148	1.2040	1.170	1.193	1.2744	1.311	1.335	1.386
5	1.1734	1.188	1.2612	1.217	1.246	1.3541	1.403	1.436	1.504
6	1.2115	1.229	1.3211	1.265	1.302	1.4387	1.501	1.543	1.631
7	1.2509	1.272	1.3838	1.316	1.361	1.5286	1.606	1.659	1.770
8	1.2916	1.317	1.4495	1.369	1.422	1.6242	1.718	1.783	1.921
9	1.3336	1.363	1.5184	1.423	1.486	1.7257	1.838	1.917	2.084
10	1.3769	1.411	1.5905	1.480	1.553	1.8335	1.967	2.061	2.261
11	1.4216	1.460	1.6661	1.539	1.623	1.9481	2.105	2.216	2.453
12	1.4678	1.511	1.7452	1.601	1.696	2.0699	2.252	2.382	2.662
13	1.5156	1.564	1.8281	1.665	1.772	2.1993	2.410	2.560	2.888
14	1.5648	1.619	1.9149	1.732	1.852	2.3367	2.579	2.752	3.133
15	1.6157	1.675	2.0059	1.801	1.935	2.4828	2.759	2.959	3.400
16	1.6682	1.734	2.1012	1.873	2.022	2.6379	2.952	3.181	3.689
17	1.7224	1.795	2.2010	1.948	2.113	2.8028	3.159	3.419	4.002
18	1.7784	1.857	2.3055	2.026	2.208	2.9780	3.380	3.676	4.342
19	1.8362	1.923	2.4151	2.107	2.308	3.1641	3.617	3.951	4.712
20	1.8958	1.990	2.5298	2.191	2.412	3.3619	3.870	4.248	5.112
21	1.9575	2.059	2.6499	2.279	2.520	3.5720	4.141	4.566	5.547
22	2.0211	2.132	2.7758	2.370	2.634	3.7952	4.430	4.909	6.018
23	2.0868	2.206	2.9077	2.465	2.752	4.0324	4.741	5.277	6.530
24	2.1546	2.283	3.0458	2.563	2.876	4.2844	5.072	5.673	7.085
25	2.2246	2.363	3.1904	2.666	3.005	4.5522	5.427	6.098	7.687
26	2.2969	2.446	3.3420	2.772	3.141	4.8367	5.807	6.556	8.340
27	2.3715	2.532	3.5007	2.883	3.282	5.1390	6.214	7.047	9.049
28	2.4486	2.620	3.6670	2.999	3.430	5.4602	6.649	7.576	9.818
29	2.5282	2.712	3.8412	3.119	3.584	5.8015	7.114	8.144	10.653
30	2.6104	2.807	4.0237	3.243	3.745	6.1641	7.612	8.755	11.558
31	2.6952	2.905	4.2148	3.373	3.914	6.5493	8.145	9.412	12.541
32	2.7828	3.007	4.4150	3.508	4.090	6.9587	8.715	10.117	13.607
33	2.8732	3.112	4.6247	3.648	4.274	7.3936	9.325	10.876	14.763
34	2.9666	3.221	4.8444	3.794	4.466	7.8557	9.978	11.692	16.018
35	3.0630	3.334	5.0745	3.946	4.667	8.3467	10.677	12.569	17.380
36	3.1626	3.450	5.3155	4.104	4.877	8.8683	11.424	13.512	18.857
37	3.2654	3.571	5.5680	4.268	5.097	9.4226	12.224	14.525	20.460
38	3.3715	3.696	5.8325	4.439	5.326	10.0115	13.079	15.614	22.199
39	3.4811	3.825	6.1095	4.616	5.566	10.6372	13.995	16.785	24.086
40	3.5942	3.959	6.3997	4.801	5.816	11.3021	14.974	18.044	26.133
41	3.7110	4.098	6.7037	4.993	6.078	12.0084	16.023	19.400	28.354
42	3.8316	4.241	7.0221	5.193	6.352	12.7590	17.144	20.852	30.764
43	3.9561	4.390	7.3557	5.400	6.637	13.5564	18.344	22.416	33.379
44	4.0847	4.543	7.7051	5.617	6.936	14.4037	19.628	24.098	36.217
45	4.2175	4.702	8.0711	5.841	7.248	15.3039	21.002	25.905	39.295
46	4.3545	4.867	8.4545	6.075	7.574	16.2604	22.473	27.848	42.635
47	4.4961	5.037	8.8560	6.318	7.915	17.2767	24.046	29.936	46.259
48	4.6422	5.214	9.2767	6.571	8.271	18.3565	25.729	32.182	50.191

Appendix 6 – Section 148 Revaluation rate for GMP

Tax year to revalue to	2022/23	2021/22	2020/21	2019/20	2018/19	2017/18	2016/17	2015/16	2014/15	2013/14	2012/13	2011/12	2010/11	2009/10	2008/09	2006/07	...	1983/84	1982/83	1981/82	1980/81	1979/80	1978/79
2023/24	7.0	11.8	14.7	19.3	22.7	26.3	29.6	32.2	34.2	35.4	37.8	40.3	43.5	45.3	49.8	62.5	...	488.3	533.6	597.6	732.9	897.0	1029.5
2022/23		4.5	7.2	11.5	14.6	18.1	21.1	23.6	25.4	26.5	28.8	31.1	34.2	35.8	40.0	51.8	...	449.8	492.1	551.9	678.4	831.7	955.7
2021/22			2.6	6.7	9.7	13.0	15.9	18.2	20.0	21.1	23.3	25.5	28.4	29.9	33.9	45.3	...	426.1	466.6	523.8	644.9	791.6	910.2
2020/21				4.0	6.9	10.1	13.0	15.2	17.0	18.0	20.1	22.3	25.1	26.6	30.6	41.6	...	412.8	452.3	508.0	626.0	769.0	884.6
2019/20					2.8	5.9	8.6	10.8	12.5	13.5	15.5	17.6	20.3	21.8	25.5	36.2	...	393.1	431.0	484.6	598.1	735.6	846.7
2018/19						3.0	5.7	7.8	9.4	10.4	12.4	14.4	17.0	18.4	22.1	32.5	...	379.6	416.6	468.7	579.1	712.8	820.9
2017/18							2.6	4.7	6.2	7.2	9.1	11.1	13.6	15.0	18.6	28.6	...	365.7	401.5	452.2	559.3	689.2	794.1
2016/17								2.0	3.5	4.5	6.3	8.3	10.7	12.1	15.5	25.3	...	353.9	388.8	438.2	542.6	669.2	771.5
2015/16									1.5	2.4	4.3	6.1	8.6	9.9	13.3	22.9	...	345.0	379.2	427.6	530.0	654.1	754.4
2014/15										0.9	2.7	4.6	7.0	8.3	11.6	21.1	...	338.4	372.1	419.8	520.7	642.9	741.7
2013/14											1.8	3.6	6.0	7.3	10.6	20.0	...	334.5	367.9	415.2	515.1	636.3	734.2
2012/13												1.8	4.1	5.4	8.7	17.9	...	326.8	359.6	406.1	504.3	623.3	719.5
2011/12													2.3	3.5	6.7	15.8	...	319.2	351.5	397.1	493.6	610.5	705.0
2010/11														1.2	4.3	13.2	...	309.8	341.4	385.9	480.2	594.5	686.9
2009/10															3.1	11.8	...	305.0	336.1	380.2	473.3	586.3	677.6
2008/09																8.5	...	292.8	323.0	365.7	456.1	565.7	654.2
2007/08																4.1	...	276.9	306.0	347.0	433.7	538.8	623.8
2006/07																	...	262.1	290.0	329.4	412.7	513.7	595.3
2005/06																		250.2	277.2	315.3	395.8	493.5	572.4
2004/05																		236.4	262.3	298.9	376.3	470.1	545.9
2003/04																		224.1	249.0	284.3	358.8	449.2	522.3
2002/03																		212.8	236.9	270.9	342.9	430.2	500.7
2001/02																		199.9	223.0	255.6	324.6	408.3	475.9
2000/01																		188.4	210.6	242.0	308.3	388.7	453.8
1999/00																		170.1	191.4	221.1	283.0	358.2	419.5
1998/99																		159.4	179.9	208.4	267.8	340.0	399.0
1997/98																		148.0	167.6	194.8	251.6	320.7	377.0
1996/97																		136.3	154.9	180.9	235.0	300.7	354.4
1995/96																		129.8	147.9	173.1	225.7	289.7	341.9
1994/95																		120.0	137.3	161.5	211.9	273.1	323.1
1993/94																		113.4	130.2	153.7	202.5	262.0	310.4
1992/93																		103.3	119.3	141.6	188.2	244.8	291.0
1991/92																		90.9	105.9	126.9	170.6	223.8	267.1
1990/91																		73.4	87.0	106.1	145.8	194.0	233.4
1989/90																		62.3	74.7	92.3	129.7	174.9	211.5
1988/89																		46.4	57.7	73.6	107.3	148.1	181.2
1987/88																		34.7	45.0	59.6	90.6	128.1	158.6
1986/87																		25.3	35.0	48.5	77.4	112.3	140.7
1985/86																		15.1	23.9	36.4	62.9	95.0	121.0
1984/85																		8.0	16.3	28.0	52.9	83.0	107.4
1983/84																			7.7	18.5	41.6	69.4	92.0
1982/83																				10.1	31.5	57.3	78.3
1981/82																					19.4	42.9	61.9
1980/81																						19.7	35.6
1979/80																							13.3

Appendix 7 - Statutory uncapped Revaluation rates for XS

							Years of Deferment													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**...**	**30**	**32**	**33**	**34**	**35**	**36**	**37**
2023	10.1	13.5	14.1	16.0	18.8	22.4	23.6	23.5	25.0	28.3	31.1	38.0		119.9	137.2	163.0	183.0	199.2	211.7	221.4
2022	3.1	3.6	5.4	7.9	11.1	12.3	12.1	13.5	16.6	19.1	25.3	29.2		106.9	138.9	157.1	171.7	183.1	191.9	
2021	0.5	2.2	4.7	7.8	8.9	8.8	10.1	13.0	15.5	21.5	25.3	23.6		108.9	149.3	163.5	174.6	183.1		
2020	1.7	4.1	7.3	8.3	8.2	9.5	12.5	15.0	20.9	24.7	22.9	29.1		130.6	162.2	173.2	181.7			
2019	2.4	5.5	6.5	6.4	7.7	10.6	13.0	18.9	22.6	20.9	26.9	31.9		143.9	168.7	177.0				
2018	3.0	4.0	3.9	5.2	8.0	10.4	16.1	19.7	18.1	24.0	28.8	33.4		151.8	170.5					
2017	1.0	0.9	2.1	4.9	7.2	12.7	16.2	14.6	20.3	25.0	29.5	33.0		154.7						
2016	-0.1	1.1	3.8	6.1	11.6	15.1	13.5	19.2	23.8	28.3	31.7	35.8		160.0						
2015	1.2	3.9	6.2	11.7	15.2	13.6	19.3	23.9	28.4	31.9	35.9	39.7								
2014	2.7	5.0	10.4	13.8	12.2	17.9	22.5	26.9	30.3	34.3	38.1	40.4								
2013	2.2	7.5	10.8	9.3	14.8	19.2	23.5	26.9	30.8	34.5	36.7	39.1								
2012	5.2	8.5	6.9	12.3	16.7	20.9	24.1	28.0	31.6	33.8	36.1	40.6								
2011	3.1	1.7	6.7	10.9	14.9	18.0	21.7	25.1	27.2	29.3	33.6	35.1								
2010	-1.4	3.5	7.6	11.4	14.4	18.0	21.3	23.4	25.5	29.6	31.0	35.2								
2009	5.0	9.1	13.0	16.1	19.7	23.0	25.1	27.2	31.4	32.9	37.1	42.1								
2008	3.9	7.6	10.5	14.0	17.2	19.2	21.2	25.2	26.6	30.6	35.3	38.2								
2007	3.6	6.4	9.7	12.8	14.7	16.6	20.5	21.8	25.7	30.2	33.0	38.2								
2006	2.7	5.9	8.8	10.7	12.6	16.3	17.6	21.3	25.7	28.3	33.4	36.3								
2005	3.1	6.0	7.8	9.6	13.2	14.5	18.1	22.4	25.0	29.8	32.7	35.1								
2004	2.8	4.5	6.3	9.8	11.0	14.6	18.7	21.2	25.9	28.7	31.0	35.7								
2003	1.7	3.4	6.8	8.0	11.5	15.5	17.9	22.5	25.2	27.5	32.0	37.5								
2002	1.7	5.1	6.2	9.6	13.6	15.9	20.5	23.1	25.3	29.8	35.2	49.9								
2001	3.3	4.4	7.8	11.7	14.0	18.4	21.1	23.2	27.7	32.9	47.4	58.6								
2000	1.1	4.3	8.1	10.4	14.7	17.2	19.3	23.6	28.7	42.7	53.5	62.3								
1999	3.2	6.9	9.2	13.4	15.9	18.0	22.2	27.3	41.1	51.9	60.5	67.3								
1998	3.6	5.8	9.9	12.3	14.3	18.5	23.3	36.8	47.1	55.5	62.1	67.1								
1997	2.1	6.1	8.4	10.4	14.3	19.0	32.0	42.0	50.1	56.4	61.3									
1996	3.9	6.2	8.1	12.0	16.6	29.3	39.1	47.0	53.2	58.0										

Year of retirement